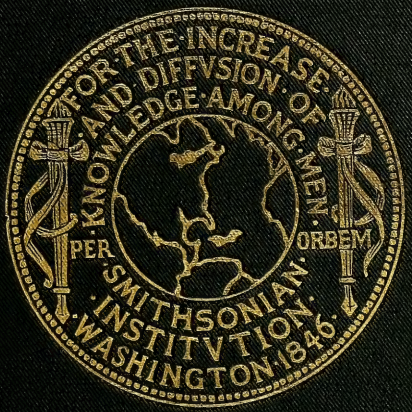
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WASHINGTON·1846·

SMITHSONIAN INSTITUTION.
UNITED STATES NATIONAL MUSEUM.

[Serial Number 45.]

BULLETIN

OF THE

UNITED STATES NATIONAL MUSEUM.

No. 34.

THE BATRACHIA OF NORTH AMERICA.

BY

E. D. COPE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1889.

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ADVERTISEMENT.

The present publication (Bulletin No. 34) is the forty-fifth of a series of papers intended to illustrate the collections belonging to the United States, and constituting the National Museum, of which the Smithsonian Institution was placed in charge by the act of Congress of August 10, 1846.

The publications of the National Museum consists of two series—the Bulletins, of which this is No. 34 in continuous series, and the Proceedings, of which the eleventh volume is now in press.

The volumes of Proceedings are printed, signature by signature, each issue having its own date, and a small edition of each signature is distributed to libraries promptly after its publication.

Full lists of the publications of the Museum may be found in the current catalogues of the publications of the Smithsonian Institution.

Papers intended for publication in the Proceedings and Bulletins of the National Museum are referred to the Committee on Publication, consisting of the following members: T. H. Bean, A. Howard Clark (editor), Otis T. Mason, John Murdoch, Leonhard Stejneger, Frederick W. True, and Lester F. Ward.

S. P. LANGLEY,
Secretary of the Smithsonian Institution.

WASHINGTON, *April* 9, 1889.

THE

BATRACHIA

OF

NORTH AMERICA.

BY

E. D. COPE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1889.

LETTER OF TRANSMITTAL.

PHILADELPHIA, *February* 18, 1887.

DEAR SIR: I have the honor to present to you for publication among the Bulletins of the United States National Museum the manuscript of a general work on the Batrachia of North America. It embraces the results of a thorough study of the characters of the species, with their variations, which has been rendered effective by the very full collection contained in the National Museum, and which this work thus illustrates. Besides this descriptive part, I have presented the results of a thorough study of the osteology of the class, based on the material contained in various museums of the United States and Europe. I have expressed these results largely in systematic form, in the belief that descriptive zoölogy will never be complete until the structure is exhausted in furnishing definitions. Wherever practicable, reference is made to the relations between the extinct and living forms.

I have been greatly indebted to you for the use of the manuscript prepared by yourself and Dr. Girard many years ago with such a publication as the present one in view. Of the descriptions of the fifty-three Urodela, nineteen are from your pen, and of the forty-seven Salientia, twenty-one are the work of yourself and Dr. Girard. This has materally lightened my labor, the only additional work necessary to these descriptions being such as increase of material has required. In the same way the figures of the external characters of the Urodela of which your descriptions appear in the text, were prepared under your direction, and the drawings of the crania of the same Urodela were partially prepared at the same time, and have been completed by myself, now appearing for the first time. The other drawings were made by myself, excepting some which are credited to others at the proper places.

Besides the collection of specimens in alcohol, the collection of skeletons prepared by yourself, and now part of the National Museum, has been of the greatest service in the preparation of this work and of the various papers by myself which have preceded it.

I am, with much respect, yours, truly,

E. D. COPE.

Prof. S. F. BAIRD,
Secretary of the Smithsonian Institution.

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THE BATRACHIA OF NORTH AMERICA.

BATRACHIA.

Bongniart, 1800. *Amphibia* Latreille, 1825 (not of Linnæus 1766).

GENERAL CHARACTERS.

Vertebrata with a distinct coracoid element of the scapular arch and with an os quadratum. The limbs consist of a single proximal element, two propodials (sometimes united), a carpus and tarsus, metapodials, and phalanges. The cartilage of the basis-cranii unossified (except sometimes a basioccipital ossification), but supported by the single membrane bone, the parasphenoid; vertebral column consisting entirely or in part of intercentra. Stapes present.

Brain with the cerebellum small, and the mesencephalon smaller than the prosencephalon ("hemispheres"); the latter with the ventricles on the inner side of their principal mass.

Heart with three chambers, two auricles, and a ventricle. Three or four aorta bows on each side. Lungs always present.

Gall-bladder and urinary bladder present; oviducts entirely distinct, and opening by fontanelles into the abdominal cavity at a distance from the ovaries. Reproductive, renal, and digestive products discharged into a cloaca. Male without distinct intromittent organ.

In development the embryonic life is prolonged during a period of freedom subsequent to leaving the egg, constituting a larval stage. During this period the young is branchiferous and generally aquatic in its habits. No amnion nor allantois. Segmentation of the yolk complete or holoblastic.

GENERAL ANATOMY.

The auditory organs resemble those of other terrestrial vertebrata, and differ from those of fishes, in the presence of a fenestra ovalis of the internal ear, which is closed by a stapes. The other ear bones or their equivalents are fused at an early stage of growth with the suspensorial cartilage of the lower jaw (Parker). There are three semicircular canals, but the helix is represented only by a diverticulum of the sacculus.

The hyoid apparatus is less complicated than that of the Pisces, and more so than that of the vertebrate classes above them in the series.

There are always a distinct so-called ceratohyal; one or more axial elements or basibranchials, and lateral pieces, or ceratobranchials. There is no glossohyal. Further than this nothing can be said of the class, as the orders differ among themselves in the details.

In the carpus and tarsus there is always an os centrale, except in the tarsus of the Salientia. In the extinct Carboniferous genera Eryops[1] and Archegosaurus,[2] there are two centralia in each foot (*pes* of Eryops unknown). The intermedium is either present or fused with one of the adjacent bones of the first row. There is a series of carpalia and of tarsalia, giving attachment to the metapodials, whose number and condition differ in the different families. The number of digits is generally not more than four in front and five behind. There is very often a rudimental thumb on the anterior foot in the Salientia, and in the extinct rhachitomous genus Eryops there are five well-developed digits on the manus. (Plate 45, fig. 1.) In the Salientia there is often a rudimental sixth toe internal to the hallux. (Plate 67–8.)

The shoulder-girdle is not connected with the skull in the Batrachia, excepting in the genus Hemisus. There is a large supra-scapula. The osseous coracoid is of various proportions, and it has various cartilaginous extensions, as epicoracoid and procoracoid. These are ossified in some of the extinct forms. There is much variety in the pieces which occupy the middle line of the scapular arch. The orders may be arranged as follows on this basis:

An episternum and no sternum: *Ganocephala, Rhachitomi, Embolomeri, Stegocephali.* An omosternum and sternum; no episternum, *Salientia.* No median sternal elements: *Trachystomata, Proteida, Urodela* (except *Trematodera*).

The pelvis is always furnished with an ilium, but the pubis is wanting or represented by rudiments, except in the extinct forms, where it is present. The ischium is primitively an undivided cartilaginous plate. No obturator foramen. There are some characters which are common to all or nearly all Batrachia, but which may be found on further knowledge of the extinct forms not to have been always present. One of these is the continuity or fixed articulation of the quadrate cartilage or bone with the skull. The proximal part of this bone is intercalated between the squamosal and exoccipital, and the pterygoid when present, so as to present only its distal extremity free. In the Salientia it is an insignificant element, being generally cartilaginous.

The vomeropalatine bones are always double, except where wanting, which is only the case in the Trachystomata. They are nearly always dentigerous.

The orbitosphenoid bone is always well developed.

In the existing orders the atlas is undivided. I have put forth the hypothesis[3] that the vertebral bodies in the existing and most of the

[1] Cope, American Naturalist, 1888, p. 436.

[2] Baur, Carpus u. Tarsus der Vertebraten, 1887, Batrachia, pp. 6–12.

[3] On the Intercentrum of the Terrestrial Vertebrata, Transac. Amer Philosoph. Soc., 1886, p. 243.

extinct orders of Batrachia are not the centra of the higher vertebrata, but are intercentra, which are occasionally seen in the higher vertebrates in a rudimental condition. This is especially the case in the remarkable saurian of New Zealand, the Sphenodon, and in the extinct order of the Theromora. Owen has shown that the intercentra exist also in the mole. I have given the following reasons for this view:

1. The intercentra are very large in the Ganocephala and Rhachitomi.
2. They support the neural arch in the Embolomeri.
3. They are not rudimental in existing Batrachia.
4. The chevron bones, which originate from the intercentra of Reptilia, are continua with the caudal vertebral bodies in Batrachia.
5. The ribs, which originate from the intercentral cartilages in Reptilia, originate from the vertebral bodies of Batrachia.

The paleontology of the Batrachia and Reptilia shows that the order Embolomeri is the only one with complete vertebral bodies, and so probably gave origin to the reptiles; while the intercentra in some Batrachians become so connected with the neural arches as to lead to the belief that they become the vertebral bodies of later forms of the class which have descended from them.

In all the orders, genera with well-developed anterior limbs display well-developed distal condyles of the humerus. They are better developed than in any order of reptiles, with the exception of the Theromora.

With regard to the cranial nerves, it is to be remarked that the lateralis branch of the vagus is present, as in fishes; also that the glossopharyngeal is united with the vagus. In the Urodela the nervus facialis is distinct from the trigeminus (Fig. 1), but in the Salientia they are united. (Plate 43.)

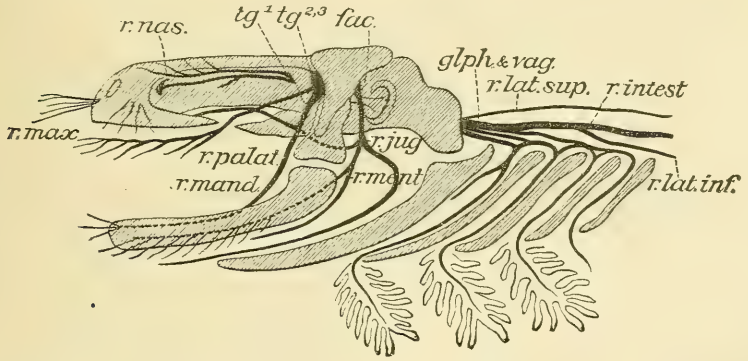


FIG. 1. Diagram of chondrocranium and cranial nerves of Salamandra, side view (from Wiedersheim).

In the muscular system the Batrachia differ from the fishes in the modifications which partially take the place of the myocommata, and the development of the muscles of the limbs and their extension on the dorsal and ventral surfaces of the body. Myocommata persist in

the caudal regions of all the tailed orders, and are transient in the tails of the larvæ of the Salientia. Remains of the same are seen in the segmented dorsal muscles of the Urodela, and the segmented median ventral, or pubosternal muscles of the tailed and tailless orders. Between these median series of muscles extend two layers, which support the sides of the body cavity, the external and internal oblique. In the Urodela the external oblique is divided up at the superior border into separate heads, each of which arises from the extremity of a rib. Between the ribs is a band of narrow longitudinal muscles—the intercostals—which are parallel to the dorsal muscles. Owing to the modification of the skeleton the dorsal muscles in the Salientia are much modified, and form chevrons with the apex posterior. The limb muscles are much like those of higher vertebrata.

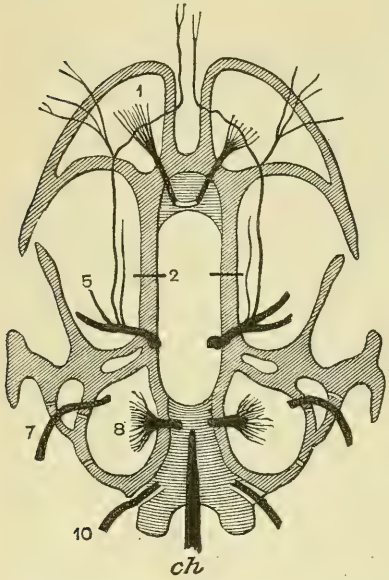


FIG. 2. Diagram of chondrocranium and cranial nerves of Salamandra, from below (from Wiedersheim).

The heart of the Batrachia possesses three chambers, two auricles and one ventricle, and there is a sinus venosus at the entrance of the vena cava. The bulbus arteriosus is not muscular, and has a longitudinal valve or partial septum, or is completely divided into two in the Proteida. In the Urodela there are four aortic branches on each side, which are in the larval state branchial arteries. As many veins return from the branchiæ and unite above the heart to form the aorta. In development to maturity the arteries become connected with the veins by longitudinal vessels, the *ductus botalli*, which complete the "aorta bows" where the branchial system disappears. The first and last of these arches become subordinate, and the intermediate on each side function as "aorta roots," whose union forms the aorta. The carotid artery is a continuation of the *ductus botalli* connecting the first and second bows, and the last bow is modified into the pulmonary vein. In the Proteida and Trachystomata three aorta bows remain on each side, and the branchial arteries and veins persist. In the Salientia three aorta bows remain, but the second on each side only form the aorta, the first and last forming the carotid artery and pulmonary vein.

The venous system consists primitively, as in other vertebrata, of two anterior and two posterior cardinal veins, which unite on each side into a single transverse vessel, the *Ductus cuvieri*, which empties into the sinus venosus. Subsequently two other pairs of longitudinal veins

arise parallel to the cardinal veins, and empty into the anterior cardinals on each side, in front of the *Ductus cuvieri*. These are the vertebral veins. The portion of the posterior cardinals between the *Ductus cuvieri* and the kidney disappears, so that what remains of the posterior cardinals are only *renales advehentes*. The anterior cardinals become the jugulars. The principal posterior vein is the *vena cava posterior*, which is median, and consists originally of the *renales revehentes* from the kidney. It receives the hepatic vein before emptying into the sinus venosus. The iliac veins pass directly into the kidney after receiving the *v. caudalis*.

The lymph cavities of the body in the Batrachia are extensive. This is especially the case with the Salientia, where the skin is loosely attached, and incloses large spaces immediately below it. The lymphatic vessels from the digestive system open into these cavities. The vessels also empty into the veins, and present at such points enlargements which contract rhythmically, and are known as "lymph-hearts." They are situated in the sacral region, one on each side, in the tailed forms, while an additional pair is present in the scapular region in the Salientia.

The reproductive and urinary systems are closely connected in the Batrachia, and must be treated of together. Both discharge their contents into the alimentary canal, forming a cloaca. Their structure is best understood by reference to that of the sharks. In these fishes a primitive longitudinal vessel on each side of the dorsum of the abdominal cavity sends branches to the outer side, which there form convoluted lobules, the primitive kidney. In the Batrachia this longitudinal or archinephric duct divides longitudinally, and the inner portion remains as the Müllerian duct. This becomes the oviduct of the female. The external half with its series of branches becomes the urogenital duct. The testes and ovaries are developed independently external to the kidneys, and the former send their efferent ducts directly into the latter. The ovaries discharge the eggs into the abdominal cavity, whence they pass into the oviducts by the free open extremities of the latter, and are thence ejected by the anus, after receiving a covering of albumen. The male organ homologous with the Müllerian duct is of reduced size in all the Salientia except the Ranæ and allies, where it is aborted. It has been shown, however, to persist in our *Rana virens*. In the Urodela the vasa deferentia pass through the kidney and enter the genitoürinary duct, and so into the cloaca; but in the Salientia the efferent ducts of the kidney collect themselves into a separate tube or ureter, which, however, joins the single vas deferens before entering the cloaca. But the Discoglossidæ agree with the Urodela in this, as in several other respects. A urinary bladder is always present in the Batrachia. The testes are single on each side in the Salientia; there are several in the Urodela, especially in the Cæciliidæ. The penis is wanting. Impregnation is accomplished by copulation in the Urodela,

but in the Salientia the spermatozoöids are discharged on the ova after leaving the body of the female. (Plates 18, 19, 32, 42.)

The alimentary canal in the Batrachia is simple, since it is not highly specialized into distinct parts. The liver is large and is divided into a varying number of lobes, which are especially numerous, and arranged like a roll of coins in the Cæciliidæ. The gall-bladder and pancreas are present. The teeth are not implanted in alveolæ, and are in the recent forms more or less pleurodont.

LARVAL CHARACTERS.

In the course of the growth of a batrachian there is always a period which follows the freedom of the embryo, in which there are structures for securing respiration in the water. These gills differ from those of fishes, in that the fringes in which the blood is aerated stand on fleshy processes of the branchial arches, and not directly on the arches themselves. Similar structures are found in the preliminary stages of some fishes. During this stage the tail is more or less modified as a swimming organ, and the condition of the skull differs materially in character from that of the adult. In the tailless or anurous Batrachia the limbs do not appear until this period has nearly closed, while in the tailed or urodele order the limbs appear almost immediately after the gills. Besides these transitional characters, the Urodela possess in their early larval condition a long process in front of the first gill on each side, which is termed a balancer. This remains in a few abnormal cases in salamanders, but is permanent in the suborder of the cæcilians or worm-like Batrachia. A similar process exists in the larva of the frogs of the genus *Xenopus*, which resembles superficially a siluroid fish; but in the Salientia generally the balancers are wanting.

The gills in the Salientia (frogs, toads, etc.) are soon concealed by a growth of the skin, which leaves a small orifice for the discharge of water from the pharyngeal cavity. In one group of these animals this opening is on the middle line below, but in the great majority it is single and is situated on the left side.

The changes undergone by the skull in the metamorphosis are much more important in the Salientia than in any other order, and are treated of under the head of that order.

The eggs of Batrachia are always deposited in the water or in damp places. In a few instances the young do not seek the water, and in one species (*Salamandra atra*) they are born free from the egg.

Under the head of the Salientia will be found a table of the various modes in which the eggs and larvæ of those animals are deposited and cared for prior to maturity.

Under the respective orders the descriptions of their characteristic peculiarities of development will be found. (Plates 30, 44, 78.)

CLASSIFICATION.

There are several orders of Batrachia, and they display remarkable diversities of skeletal structure. For the better understanding of these I give the following table of their principal definitions:[1]

I. Basioccipital, supraoccipital, intercalary,[2] and supratemporal bones present. Propodial bones distinct.
  a. One cotyloid occipital condyle.
    Vertebral centra replaced by one basal and two lateral elements with one neural arch ..... *Ganocephala.*
  aa. Two occipital condyles.
    Vertebral bodies, including atlas, segmented, one set of segments together supporting one arch ..... *Rhachitomi.*
    Vertebræ segmented, the superior and inferior segments each complete, forming two centra to each arch ..... *Embolomeri.*
    Vertebral bodies, including atlas, not segmented; one to each arch ..... *Stegocephali.*

II. Basioccipital, supraoccipital, and supratemporal bones wanting. Frontal and propodial bones distinct.
  a. An os intercalare.
    A palatine arch and separate caudal vertebræ ..... *Proteida.*
  aa. No os intercalare.
    A maxillary arch and vomers; palatine arch present, imperfect; nasals, premaxillaries and caudal vertebræ distinct ..... *Urodela.*
    No maxillary or palatine arches; no vomers; nasals and premaxillary, also caudal vertebræ, distinct ..... *Trachystomata.*

III. Basioccipital, supraoccipital, intercalare, and supratemporal bones wanting. Frontals and parietals connate; propodial bones and lumbosacral vertebræ each confluent.
    Palatines distinct from vomers; a palatine arch; astragalus and calcaneum elongate, forming a distinct segment of the limb ..... *Salientia.*

The animals of the Division I are all extinct. Division II includes the Salamanders and their allies, with the worm-like Cœcilians (Apoda), while the third division embraces the frogs, toads, etc.

AFFINITIES.

The Batrachia are, then, intermediate in characters, and therefore in position, between the fish-like forms and the reptiles. Among the former the Dipnoi approach them most nearly, while the extinct reptiles of the oldest order, the Theromora,[3] are the nearest allies on the reptilian side. It belongs to the series of vertebrates which have a distinct coracoid bone in the shoulder-girdle, and a distinct quadrate bone in the skull. The greater part of the basicranial axis is cartilaginous, but it is protected below by the membrane bone, the parasphenoid. In all these respects, and in the absence of an amnion of the embryo, the Batrachia agree with the fishes. They differ from this class in the presence of legs and absence of fins, and in the absence of various bones which belong to the branchial and opercular systems, and to the suspensor of the lower jaw.

[1] This is partly derived from the table which I have given in Vol. II, Palæontology of the Geological Survey of Ohio, 1874, p. 352. See also American Naturalist, 1884.

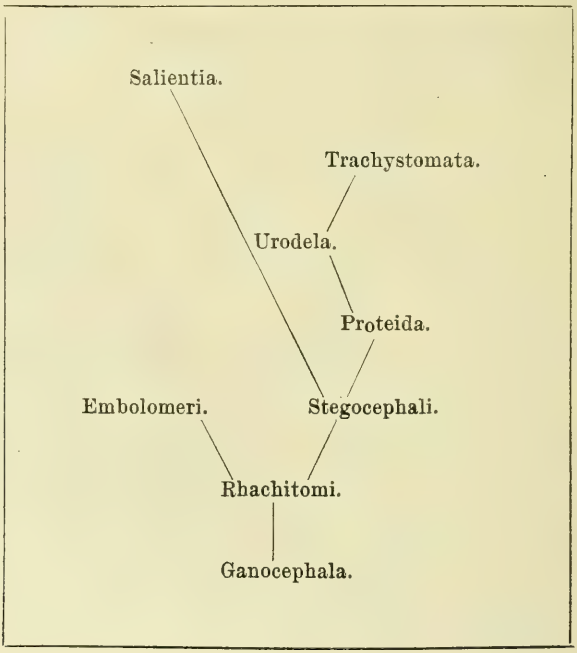
[2] Of Cuvier: Epiotic of Huxley, according to Vrolik.

[3] *Theromorpha* Cope olim; name preoccupied.

The characters displayed by the three divisions in question indicate their relationship to be as follows: The orders of Division I present in their cranial structure a greater resemblance to the limb-finned or crossopterygian fishes than do either of the others. The third division is the most divergent from the type, and is in various respects the most specialized. This specialization consists not only in a departure from the primitive Batrachia, but also from all other forms of vertebrata. Its specialization is seen in the loss and coössification of various parts of the skeleton. The Urodela display characters intermediate between the extremes of the class. Near them the Trachystomata (Sirenidæ) are still more inferior by loss of parts of the skull and of the pelvic arch. The Proteida have lost the maxillary arch of the Stegocephali, but retain their os intercalare.

PHYLOGENY.

The class Batrachia holds an important position in the history of the vertebrata, as the first member of that kingdom which occupied the land on the advent of the conditions suitable for air-breathing types. It thus stands in ancestral relation to the lines of the Sauropsida and Mammalia, and as the immediate descendants of the fishes. As regards the extinct orders, the primitive type is evidently the Ganocephala, whose vertebral column displays an arrest of characters which are transitional in the higher vertebrata. From this group the orders Rhachitomi, Embolomeri, and Stegocephali have been evidently derived. We may then present the following genealogical table of the class Batrachia:



As regards the connection of the class, as a whole, with other classes of vertebrata, it is very probable that the extinct orders, as the Ganocephala, were derived from some extinct form of Dipnoan fishes, more or less related to the group of which the genus Ceratodus is a representative. In this type we have a persistent chorda dorsalis, fins which present the type from which ambulatory limbs were derived, a pelvis, and a cranium nearer that of the batrachians than most other fishes present. The Crossopterygia are a little on one side of the parental stem, since they have no pelvis, and their limbs begin to show a beginning of that reduction and specialization which is carried to such an extent in the Actinopterygia, or typical fishes.

From the Ganocephala we derive the remaining orders, all of which possess two occipital condyles. The intercentra, which are small in the prepelvic vertebral axis of the Ganocephala, assume a large development in the Embolomeri, which thus have two bodies to each neural arch throughout the series. It is probable that the reptiles took their origin from this group by the gradual reduction of the intercentra, and the continued dominance of the centra. It is possible also that the Embolomeri possess but one occipital condyle, which, uniting with an intercentrum, formed the single occipital condyle of the Reptilia.

In the direction of the Rhachitomi there is reason to believe that the intercentra became predominant in the vertebral axis, and that the centra soon disappeared. This order gave origin to the Stegocephala, in which the centra are wanting; and this order was the source of the Proteida on one hand, and the Salientia on the other. The former, of all the existing orders is the only one which retains the *os intercalare* of the Palæozoic types. From the Proteida we get the Urodela, and from the latter the Trachystomata, as will be more especially shown under that order.

The Ganocephala (Trimerorhachis) and the Rhachitomi (Zatrachys) had a well developed columella auris, which extended from the fenestra ovale and turned upwards and backwards to the notch of the posterior outline of the skull between the *os intercalare* and the base of the quadrate. It is highly probable that this notch was occupied by a tympanic drum.[1] In the Proteida, Urodela, and Trachystomata, there is no columella. In the Salientia there is a chain consisting of one bone and two cartilages extending between the stapes and the *membranum tympani*. Thus the Urodela in this respect have undergone degeneration, while the Salientia have undergone specialization. With regard to other parts of the skeleton all the later and recent orders must be regarded as having undergone degeneration, in view of the extensive loss of parts. (See Origin of the Fittest, by E. D. Cope, On the Evolution of the Vertebrata, progressive and retrogressive.)

[1] See Cope On the ossicula auditus of the Batrachia, Amer. Naturalist, 1888, p. 464; Journal of Morphology, November, 1888.

EXPLANATION OF TERMS.

The *Canthus rostralis* is the ridge more or less defined which marks the line of separation anterior to the eyes, between the top and side of the head. The *outer nares* or *external nostrils* are situated in or a little below this angular line, and between the eye and tip of snout. The *Canthus orbitalis* is the corner of the eye, either anterior or posterior. By *ramus* of jaw is meant either of the two branches, one on each side. The *rictus* is the point of junction between the upper and lower jaws. The *commissure* is the line along which the two jaws meet when closed. The *internal nares* or *choanæ* are in the roof of the mouth a little anterior to the eyes. The Eustachian apertures, or ostia pharyngea, are situated very far back in the roof of the mouth near the end of the jaw, one on each side. The *angle of the jaw* is just behind the point of articulation of the two jaws. The *concealed surfaces* of the body are those which are internal and pressed against each other when the limbs are flexed. The teeth in the roof of the mouth are *vomerine* or vomeropalatine when they are within or near the inner nares, and on the bone of same name; and they are parasphenoid, or loosely, *palatine*, when considerably behind the level of the inner nares and placed on the parasphenoid bone.

The enumeration of the fingers and toes commences with the inner ones, the fourth finger and the fifth toe being the external. The term finger always belongs to the anterior extremities, and toe to the posterior. The phalanges are numbered from the metapodial bone. By *articulation* is understood the hinge between two adjacent bones, which themselves are called segments. The tympanum or membranum tympani is the circular disk seen on each side the head, posteriorly and just back of the eye, in the Salientia.

NOMENCLATURE AND HISTORY.

By *Linnæus*, in the tenth edition of the Systema Naturæ (1760), in the twelfth (1766), and in the thirteenth (1788) reptiles and batrachians are included in a class "Amphibia." The two classes were not recognized even as subordinate divisions of the Amphibia. These divisions were the Reptiles, Serpentes, and Nantes. The last named included only fishes. Four genera were included in the reptiles, one of which was Rana, which embraced all the Batrachia Salientia. The Urodela were enumerated as species of the genus Lacerta. The genus Cœcilia was placed among the Serpentes.

Laurenti, in the Tentamen Systema Reptilium, 1768, first used the class name Reptilia for a combination of the two classes, Reptilia and Batrachia, as at present recognized. He proposed three orders of Reptilia, the Salientia (= Batrachia Anura), the Gradientia (= lizards and Batrachia Urodela), and the Serpentes, in which he included the Cœcilias.

Lacépède, 1788–'90, did not distinguish Reptiles from Batrachia, and

did not give distinctive names for the groups which he proposed, which were very artificial.

Brongniart published his system in 1800–'03, in the Mémoires des Savans Étrangers de l'Institut. He did not distinguish the Batrachia as a class from the Reptilia, but he distinguished it first as a natural group and named it. He divided the Reptilia into the four orders, Chelonia, Sauria, Ophidia, and Batrachia. He placed the salamanders in the Batrachia for the first time.

Latreille published a system of Reptilia in the Nouveau Dictionaire d' Histoire Naturelle in 1804, Vol. XXIV, page 61. He adopts the system of Brongniart. The Batrachia are divided into two sections: I *B. coureurs*, and II *B. pisciformes*. The second section included the genera Proteus and Siren; section I, all other Batrachia known to the author. In 1825 Latreille published another classification in the brochure "Les Familles Naturelles du Régne Animal." He divides the vertebrata into warm-blooded (Haemathermes) and cold-blooded (Haemacrymes). The latter include Pulmonées and Solibranches. The latter includes the fishes. The former division has two subdivisions, Reptiles and Amphibia or Batrachia. We here find the system of De Blainville adopted in the recognition of the Batrachia as distinct from the Reptilia, and the name Amphibia is used for it for the first time.

Daudin in 1802–'03 published his Traité Générale. He adopted the classification of Brongniart.

Duméril, in 1804, in the Traité élémentaire d'histoire naturelle, also adopted the system of Brongniart. He placed the Cœciliidæ among the Ophidia. In his Zoölogie Analytique, published in 1807, he followed the same arrangement, and divided the Batrachia into Anura and Urodela. The latter included four genera: Triton, Salamandra, Proteus, and Siren.

Lamarck, in 1809, published a Distribution Genérale des Animaux, as the chapter VIII of the Philosophie Zoölogique. He did not distinguish the Batrachia from the Reptilia as a class, but recognized the four orders of Reptilia already proposed by Brongniart. The Batrachia are divided into two divisions: Urodela and Anura. Cœcilia is placed in the serpents.

Cuvier, in the Leçons d'Anatomie Comparée, in 1800, and in the Règne Animal, in 1817, adopted the system of Brongniart. In the second edition of the latter, published in 1829, he divides the Batrachia into five genera, viz: Cœcilia, Rana, Salamandra, Proteus, and Siren.

Oppel published his "Ordnungen Familien u. Gattungen der Reptilien" in 1811 (Munich). He adopts the class name Reptilia, and divides it into three orders: Testudinata, Squamata (snakes and lizards), and Nuda or Batrachia. The Batrachia are divided into three families: the Apoda (Cœciliidæ), Ecaudata or Anura, and the Urodela.

De Blainville published in 1816 in the Nouveau Bulletin des Sciences de la Société Philomathique of Paris a Prodrome d'une nouv. distribu-

tion systematique du Règne Animal. He first proposed to regard the Batrachia as a distinct class of vertebrata, the IV of his series, under the name "Nudipellifères, les Amphybiens." On a subsequent page he divides the class Reptilia into two subclasses, "les Reptiles" and les Ichthyoïdes. The latter are subdivided into four divisions, viz: Batraciens (Grenouilles); Pseudosauriens (Salamandres); Amphibiens (les Protées et les Sirènes); Pseudophidiens (Cœcilies). We here find the Batrachia for the first time set off from the Reptilia as a division of equal rank with it.

Merrem, Tentamen Systemæ Amphibiarum, 1820, reverts to the Linnæan name Amphibia for the combined reptiles and batrachians, but recognizes the two as subordinate divisions. He calls these Pholidota and Batrachia. The Batrachia he divided into the Apoda (Cœcilia), Salientia, and Gradientia. The Gradientia or Salamandres are divided into Mutabilia (Salamandra, etc.) and Amphipneusta, or the forms with permanent branchiæ.

Gray published in 1825, in the Annals of Philosophy of Philadelphia, a synopsis of the genera of Reptilia and Batrachia of North America. He separates the two classes distinctly as such under the names Reptilia and Amphibia. The former are divided into the orders Emydosauria (crocodiles and extinct marine reptiles), Sauria, Saurophidia, Ophidia, and Chelonia. The Amphibia were divided into Mutabilia and Amphipneusta. The latter division included the branchiate forms, with the Cryptobranchidæ and the Cœciliidæ. The Mutabilia embraced all other Batrachia.

Harlan also, in 1825, published Genera and Synopsis of Species of Reptiles of America in the Journal of the Academy of Natural Sciences of Philadelphia. He adopts the system of Brongniart, and divides the Batrachia into three divisions, dependent on the characters of the external respiratory organs. In the first there is an external fissure only; in the second, external branchiæ and fissures; and in the third, neither the one nor the other.

Fitzinger, Neue Classification der Reptilien (1826), adopts the names of Leuckart for the primary divisions of the Reptilia, the Monopnoa corresponding to the Reptilia and the Dipnoa to the Batrachia. He places Cœcilia among the Monopnoa. The Dipnoa are divided into Mutabilia and Immutabilia. The latter includes the families Cryptobranchoida and Phanerobranchoida. The Mutabilia include all other Batrachia.

Duméril and Bibron, in the "Erpetologie Générale," published between 1834 and 1841, adopt the system of Brongniart. The fourth order of reptiles, the Batrachia, is divided into three suborders, viz: the Peromela (Cœciliidæ), Anura, and Urodela. The Urodela are divided into Atretodera (Salamandres) and Trematodera, which embraces the Cryptobranchidæ and forms with permanent branchiæ.

Johannes Müller, in Stannius' Handbuch der Zoötomie (1856), uses the Linnæan name Amphibia for the combined Reptilia and Batra-

chia. The latter two divisions he regards as subclasses, under the names Monopnoa and Dipnoa. The Dipnoa (Batrachia) are divided into Urodela and Batrachia (=Anura). The Urodela in turn are divided into Perennibranchiata, Derotremata (Trematodera pt. of Duméril and Bibron), and Myctodera (salamanders in general).

Haeckel published in 1866 his Generelle Morphologie. He then distinguished the Batrachia not only as a class from the Reptilia, but placed it in a separate group of the vertebrata, which he called the Anamnia, from the absence of the amnion, along with the fishes. He uses indiscriminately the names Batrachia and Amphibia for the class. He divides it into two primary divisions, the Phractamphibia and Lissamphibia. The former are the extinct forms, together with the Cæciliidæ. The Lissamphibia are divided into three divisions: Sozobranchia (Perennibranchs), Sozura (Urodela), and Anura.

Cope, in a "Synopsis of the Extinct Batrachia of North America," 1868 (Proceedings of the Academy Philadelphia), recognized the Batrachia as a class distinct from the Reptilia, and divided it into six orders, as follows: Trachystomata (Sirens), Proteida, Urodela, Gymnophidia (the Cœciliidæ), Stegocephali (extinct forms), and Anura. In a paper on the Batrachia of the Permian Period of North America, 1884 (American Naturalist), two orders were added, the Rhachitomi and Embolomeri, both extinct. In the "Origin of the Fittest" (Philadelphia, 1886) still another order is added to the Batrachia, the Ganocephala of Owen, and the Gymnophiona (Cœciliidæ) are united with the Urodela, making eight orders in all. This system is adopted in the present work. In 1865, in a paper on the Primary Divisions of the Batrachia Salientia (Natural History Review) the Anura were divided into Aglossa, Bufoniformia, Arcifera, and Raniformia. These divisions are here adopted, excepting the Bufoniformia.

Huxley, Anatomy of Vertebrated Animals, 1871, divides the vertebrata into Ichthyopsida, Sauropsida, and Mammalia. The Ichthyopsida correspond to the Anamnia of Haeckel, plus the Leptocardii and Marsipobranchii. This division is divided into two classes, the Pisces and Amphibia (Batrachia). The Reptilia and Aves form the Sauropsida. The Amphibia embrace, according to Huxley, four orders, viz: Urodela, Labyrinthodonta, Gymnophiona, and Batrachia or Anura. The Urodela are divided into Proteida and Salamandrida, which correspond to the Trematodera and Atretodera of Duméril and Bibron. Professor Huxley gave the first clear osteological definition of the class.

Gegenbaur, in the Elements of Comparative Anatomy, 1872, follows the system of Haeckel so far as regards the higher groups of vertebrata. The Batrachia are called Amphibia, and have the three divisions proposed by Merrem, but under the names Urodela, Anura, and Gymnophiona.

In the preceding review no attempt has been made to present the views of all naturalists who have written on the vertebrata, but I have

endeavored to include all the works in which the Batrachia and their internal and external relations have been expressly considered and new views introduced. The system which appears to the writer to express most fully the natural relations of the contents of the class is presented in the following pages. But I devote a few words to nomenclature.

The earliest name for a given conception derived from individuals is adopted. Species must be defined or figured; genera and all higher groups must be defined, since figures can not express the generalizations such names are intended to represent. As the conception of the extent of a genus varies with discovery, it is impossible to require that the definition accompanying its earliest name shall be necessarily exact, so that a bona fide definition is all that is obligatory, according to the rules. In the case of the higher groups the case is different. It has been customary to require that the definition accompanying the name adopted shall correspond with the thing adopted. If the definition does not so correspond, the name has generally remained unused. Such names are the Mutabilia and Immutabilia, Caducibranchiata and Perennibranchiata, which have been applied to systematic ideas not in correspondence with the true relationships of the members of the Batrachia. They have fallen accordingly into disuse. Such are also the so called orders Emydosauria and Saurophidia. The division then receives the name which was first applied to it, and not to something more or less corresponding to it on ommission or addition of contents. The rank assigned to such division is immaterial; the idea of the division itself is everything.

Applying these principles to the vertebrates which form the subject of this book, I find the following to be the names to be adopted. I find that Brongniart first perceived the correct limitation of the Batrachia, and that in 1800 he gave it that name. In this he was followed by Latreille in 1804; by Daudin, in 1802–3; by Duméril, in 1804; by Lamarck, in 1809; by Cuvier, in 1800 and in 1817; by Merrem, in 1820; by Harlan, in 1825; by Duméril and Bibron, in 1841; and by various modern writers since that date. The name Amphibia I find first used by De Blainville in 1816 as interchangeable with the name Nudipelliferi, and also as a subdivision of itself equal to the Perennibranchiates of some later authors. The name is first definitely adopted by Latreille in 1825, a quarter of a century after the introduction of the name Batrachia. He is followed after a long interval by Haeckel in 1866, who, however, uses the name Amphibia as interchangeable with Batrachia. It is exclusively used by Huxley and by Gegenbaur, and by a number of modern naturalists, chiefly anatomists. From the above record it is quite evident that the proper name for this class is Batrachia.

The true classification of the contents of the class was of much later discovery. The tailless division was recognized, it is true, by the earlier authors; and, first of all, in 1768 by Laurenti, who called it the Salientia and gave it a definition. This name must be therefore retained. The divis-

ion of true Salamanders was not properly distinguished before the publication of the system of De Blainville, in 1816, who called them the Pseudosauria. He, however, omitted from them the Cæciliidæ. In this omission he was followed by all subsequent authors, except Cope, who called the entire order, including the Cœciliidæ, the Urodela, adopting a name already proposed by Duméril, in 1804, for a division of wider scope. On this account the name Urodela is adopted in the present work. The name Gradientia was first used to include only Batrachia, without lizards, by Merrem, in 1820. The two branchiate orders, Proteida and Trachystomata, were included in the Urodela or Gradientia by all authors except the following: De Blainville combined them in one order, the Amphibia; Gray, Harlan, and Fitzinger followed, but combined them with unrelated forms; Duméril and Bibron kept them together with the Cryptobranchidæ in a division, Trematoderes, following Fitzinger (1826); Haeckel follows De Blainville, but renames the Pseudosauria of that author Sozobranchia, and includes in his Amphibia the non-related Axolotls. In 1866* Cope first distinguished the Trachystomata and Proteida as orders, and purged them of the Axolotls, which he placed in the Urodela.

PROTEÏDA.

Os intercalare present; no supra or basioccipitals; *O. maxillare* and *prefrontalia* wanting; vomero-palatinum and pterygoideum present, continuous; orbitosphenoid elongate, not forming part of palate; ceratohyals connate.

This order agrees generally with the Urodela, but presents one most important feature of difference, in the presence of the Os intercalare. It is this point that gives the Proteida its position between the Stegocephali and the Urodela, and which indicates the line of connection between the extinct forms of the Carboniferous period and the modern types.

The hyoid apparatus differs from that of adult Urodela, and resembles their larvæ in having three epibranchials, instead of one only. The second basibranchial is also connected with the first, which is not the case with the Urodela. The centrale is present in both carpus and tarsus.

No extinct genera are certainly known to belong to this order, but there is one that resembles it nearly, and may belong here. This is the Cocytinus† (Cope), which has been found in the coal measures of eastern Ohio. If it be not a larval Stegocephal, it belongs to this order. It would not enter the same family as the recent forms, as it has a small maxillary bone. Another extinct type from the Wealden of Belgium has been suspected to belong to the Proteida, but the cranium is not

* On the Arciferous Anura, Journal Academy Philadelphia, 1866, p. 102.

† Geological Survey of Ohio, II, Paleontology.

sufficiently well preserved to allow of a positive determination. This is the *Hylæobatrachus croyii* of Dollo.* It differs from any of the known genera of the order in having five digits on all the feet.

There is but one existing family of Proteida, which is defined as follows:

PROTEÏDÆ.

No median sternal elements. Vertebræ amphicœlous. Carpus and tarsus cartilaginous. Inner wall of vestibule osseous. Nasalia wanting. Teeth on all the usual bones except the maxillaries, which are wanting. The second ceratobranchial is present, as in Urodela generally. Stapes directly connected with the suspensorium.

Of this family but two genera are known. They are the following:

External branchiæ; digits 4–4; eyes exposed ..... *Necturus.*
External branchiæ; digits, 3–2; eyes hidden ..... *Proteus.*

Of these Necturus is North American and Proteus is European. The latter is represented by three or four species, which live in subterranean waters in the southern parts of Austria.

These genera differ somewhat in the hyoid apparatus. The hypohyal is present in Necturus, but is, according to Wiedersheim, wanting in Proteus. In the former the second ceratobranchial is much smaller than in the latter, and is not connected with the basibranchials.

The connections between the inferior arches and the skull are interesting. In Necturus the columella is osseous and is bent abruptly forwards, and articulates with a short posterior process of the squamosal bone. The ceratohyal is free from the skull, but is connected with it by the two ligaments, the hyosuspensorial to the middle of the quadrate, and the mandibulohyoid, to the angle of the mandible. (Plate 48, fig. 1.) In Proteus (Fig. 2) the arrangement is similar, except that the processes of the stapes and squamosal do not meet, but are connected by a strong ligament.

The intermedium of the carpus and of the tarsus is confluent with the adjacent external element, the ulnare and the fibulare. There are three carpalia and three tarsalia, the internal on the inner side of the carpus and tarsus. The carpus and tarsus are thus very much alike. (Plate 45, fig. 2.)

The procoracoid cartilages are distinguished from the coracoids, but are continuous at the point of junction with them. They are much produced forwards in Necturus. The coracoids meet on the middle line. No sternum. The ilium is the only ossified part of the pelvis. It is connected with the single sacral vertebra by a true rib, which is rather larger than the others. The inferior elements of the pelvis are continuous cartilage. In Necturus the ischiadic portion is subquadrate, while the public portion forms a triangle, well produced forwards to an acute-angled apex. Femur with a trochanter in Necturus.

* Bulletin du Musée Royal du Belgique, 1885, p. 85.

NECTURUS Rafinesque.

De Blainville's Journal Physique, LXXXVIII, 1819, p. 417; Wagl. Nat. Syst. Amphib., 1830, p. 210; Gray, Catal. Brit. Mus., ed. I, p. 66; Boulenger, Catal. Bat. Grad. Brit. Mus., ed. II, 1882, p. 83.

Phanerobranchus, part., Leuckart, Isis, 1821, p. 260. Fitzing., Neue. Classif. Rept., p. 68, 1826.

Menobranchus, Harlan, Ann. Lyc. N. Y., I, 1825, p. 221; Tschudi, Batr., p. 97; Dum. & Bibr., IX, p. 183.

External gills persistent. Fingers and toes, four; vomeropalatine teeth in a single series. Eyes exposed.

This genus is distributed throughout the eastern district of North America only, where it is represented by two species. These are distinguished among other characters by the following:

Muzzle longer, more depressed; branchiæ shorter; teeth, premaxillaries 11–15; vomerines 12–16; brown, darker spotted; larger.....*N. maculatus.*

Muzzle shorter, less depressed; branchiæ longer; teeth, premaxillaries 6–8; vomerines 8–9; pale, unspotted; smaller.....*N. punctatus.*

NECTURUS MACULATUS Raf.

Plates I–III.

Necturus maculatus, Rafin., l. c.; Holbr., N. A. Herp., V, p. 111, pl. 37; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 84.

Triton lateralis, Say, in Long's Exped. Rocky Mts., I, p. 5.

Phanerobranchus tetradactylus, Leuckart, l. c.

Menobranchus lateralis, Harlan, l. c.; Tschudi, Batr., p. 97; Holbr., l. c., p. 115, pl. 38; Dekay, N. Y. Faun., Rept., p. 87, pl. 18, f. 45; Dum. & Bibr., p. 183; Wied, Nova Acta Leop.-Carol XXXII, p. 138, pl. 7, f. 1.

Menobranchus tetradactylus, Harlan, Journ. Ac. Phla., IV, p. 324; Gray, Ann. Philos., X, 1825, p. 216.

Menobranchus sayi, Gray, l. c.

Necturus maculosus, Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 66.

Proteus maculatus, Barnes, Amer. Journ., XI, p. 258.

Menobranchus lacepedii, Gray, in Griff. A. K., IX, p. 108.

Phanerobranchus lacepedii, Fitz., l. c.

Necturus lateralis, Wagl., l. c.

Siredon hycmalis Kneeland Proceeds. Boston Soc. Nat. Hist., vol. VI, p. 152, 1856; p. 218 (1857).

Menobranchus hycmalis Kneeland, l. c., p. 280, 1857.

In this species the body is only moderately elongate, measuring, with the head, four and a half to five times the greatest width of the latter. The body is depressed, though not so much so as that of the known species of Cryptobranchus. The section of the tail at the base is a vertical oval; beyond this point it is more compressed, so that the distal half is flat and oar-like, with a wide dermal border above and below. The length of the tail varies somewhat. It usually enters twice into the length from its base to a point posterior to the eye, but sometimes this point is anterior to the eye, and even rarely as far as the end of the muzzle.

The head is a flat oval, and the muzzle is flat, rather short, and somewhat truncate in outline. The eye is situated anterior to the middle of the head and is quite small, its longer diameter entering the interorbital

space five times. The nostrils are small, and are situated near the border of the lip. The distance between them equals from three-fifths to two-thirds the interorbital space. The upper lip is rather full and has a thin edge. It overhangs the lower lip, concealing the posterior part of it, and embracing it at the canthus, since it is attached within the groove which bounds it below. The lower lip is decurved, and the anterior part is deeper, or more convex downwards, than the posterior half, and is separated from the corresponding part of the opposite side by a considerable interspace, which is without groove.

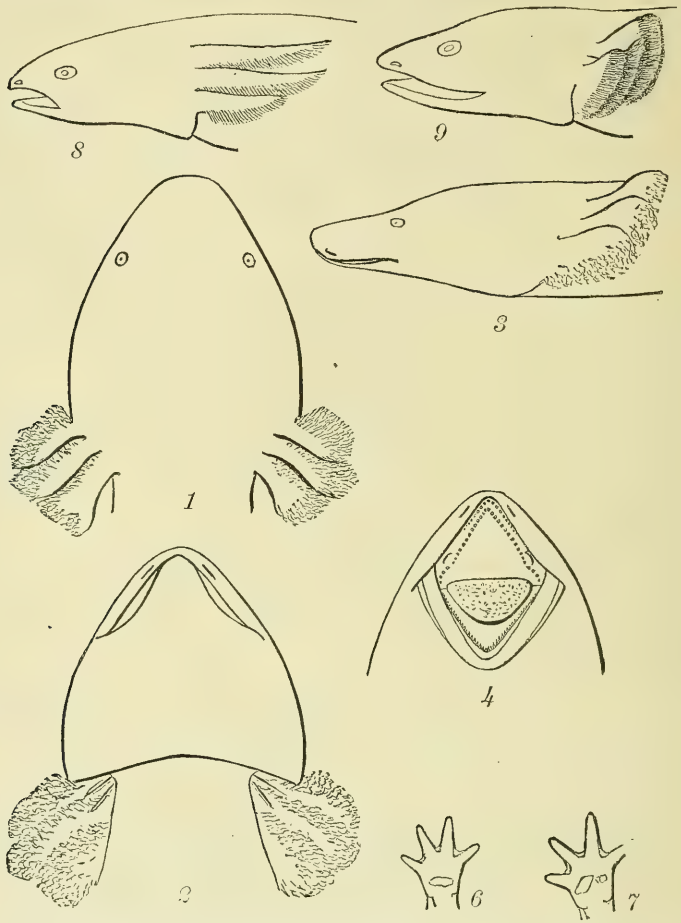


FIG. 3. 1–7, *Necturus maculatus* Raf., No. 8815, Mount Carmel, Ill.; 8, *Siredon mexicanum* Wagl., larva, head; 9, *Chondrotus tenebrosus* B. & G., larva, head. All natural size.

The branchial processes are undivided, and form vertical plates, which thin out downwards. The external and internal faces, the inferior margin, and the free extremity are fringed with rather short fimbriæ. The anterior processes are shorter than the two others, which are subequal. The longest about equals the length of the muzzle from the eye;

they are frequently shorter. In two specimens from Kingston, Upper Canada, they exceed the length of the muzzle, but this is very seldom the case.

The tongue does not reach the symphysis of the lower jaw, and is obtusely rounded in front. It is considerably free anteriorly. The internal nostrils are an oblique slit on each side, which lies obliquely and opposite to the interval between the vomerine and pterygoid teeth. The premaxillary teeth are in two straight divergent series, which unite at a rounded angle in front, which would be, if completed, a little less than a right angle. Each side usually contains eleven teeth, but there are sometimes thirteen and in one large specimen (No. 8560) fifteen teeth. The vomerine series is parallel within the premaxillary, forming, like them, an obtuse angle anteriorly. There are twelve or thirteen teeth on each side, but sixteen in the large specimen (No. 8560). Immediately posterior to these and at a short interval, the pterygoid series commences. It is slightly convex outwards, and embraces usually six teeth, rarely five, and in the large (No. 8560) ten teeth. The dentary bone supports twelve or thirteen teeth, which are directed obliquely inwards at a slight angle. The splenial bone supports four and sometimes five teeth, which form a short series posterior to those of the dentary bone, whose base ascends gently backwards. In two specimens from Grass River, N. Y. (No. 7038) the teeth are rather fewer in number, viz: Premaxillaries, eleven; vomeropalatines, eleven; pterygoids, four.

The limbs are well developed, but short and weak, as in salamanders generally. The two external fingers are subequal in length, and shorter than the two middle ones, which are also subequal. There are no distinct palmar or subdigital warts. The phalanges are, beginning on the inner side, 1–3–3–2. The toes are all unequal. The inner is the shortest; then follow in order the fourth, the second, and the third. There are no solar or subdigital tubercles. The phalanges number 1–2–2–2. The limbs are of about equal length, and are equal to the width of the head just in front of the branchiæ. Pressed to the side, they are separated by a distance equal to one length and a half of either of them.

The skin is entirely smooth, and has no longitudinal lateral fold. There are fourteen transverse folds—very rarely fifteen—which are not visible on the belly nor on the median dorsal region. A fold crosses the throat, connecting the branchial fissures; it is not very profound, and becomes obscure in specimens which have not been well preserved. There are two branchial fissures only, there being none behind the posterior branchial arch. The vent presents two short obtuse processes inwards and backwards at the posterior part of its lateral borders. Anterior to these there are three short processes, one on each side and one at the anterior angle, which are principally composed of fine pappillæ. Besides these, the entire walls are pappillose. These are especially prominent at the breeding season.

Measurements of No. 9897.

	M.
Total length	0.360
Length to end of vent	.250
Length to opposite groin	.220
Length to opposite axilla	.080
Length to opposite anterior branchia	.055
Length to opposite eye	.015
Width of head at eyes	.036
Width of head between eyes	.023
Greatest width of head	.046
Length of anterior limbs	.040
Length of posterior limbs	.043
Depth of tail at middle	.035

The ground color is a light chocolate brown, which is sometimes tinged with pink, and which is usually rendered lighter in tint by an infinitude of whitish specks and small spots, which reduce the ground to a minute reticulate pattern. On this ground are distributed several rows of spots of dark brown, which are quincuncially arranged, not very close together, in from four to eight or nine irregular longitudinal rows. These are wanting on the belly, but are continued on the tail. The inferior surfaces are dirty white, clouded with the color of the back, but they are sometimes colored like the back, including the dark spots. The soles and palms are yellowish. A dark brown band passes along the canthus rostralis through the eye, and extends some distance posterior to it. In young specimens this band extends to the end of the tail, involving the greater part of the sides. It is bordered above by an ochreous yellow band, which also extends from the end of the muzzle to the end of the tail. The median line of the head and back is dark brown, this color ceasing above the vent.

An entirely black variety has been sent me by Dr. J. G. Garnier of Lucknow, Ontario, which he has obtained from the Maitland and Lucknow Rivers. The only variation in the color consists of two obscure band-like aggregates of yellowish-brown specks along the inferior and superior borders of the muscular part of the tail.

Habits.—Dr. Samuel Kneeland, of Boston, gives an account of the habits of two individuals of this species which he kept several months in confinement. They were very hardy, having been frozen and thawed several times during the winter. They were quite rapacious, eating worms and fishes. They were most active at night, and during the day avoided the light. They cleaned their branchiæ by stroking them with their anterior feet. The fibrillæ were alternately expanded and contracted by pressure of blood and its absence.

As may be seen from the following list, this species ranges throughout the tributaries of the Great Lakes and the Mississippi, as well as the rivers that flow into the Gulf of Mexico and the Atlantic Ocean, as far north as the Tar River, North Carolina. It has not yet been found in either the Floridan or the Texan districts.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8348	2	Kinston, N. C		Mason & Welsher	Alcoholic.
7897	2	Grand Ecorse, Mich		J. W. Milner	Do.
8350	2	Clarkston, Mich		do	Do.
8560	1	Manitoba	Oct. —, 1875	M. Banks	Do.
8815	1	Mount Carmel, Ill	June —, 1875	Samuel Turner	Do.
9203	1	Great Lakes			Do.
9207	2	Grand Ecorse, Mich		C. M. Clark	Do.
7907	3	do		G. Clark	Do.
10896	1	Geneva Lake, Wis	July 26, 1881	H. W. Welsher	Do.
10897	1	do	do	do	Do.
4530	2	Burlington, Vt		Prof. S. F. Baird	Do.
7041	1	Tyree Springs, Tenn		Dr. R. Owen	Do.
7007	1	Lake Superior		D. Gunn	Do.
3967	3	Cook County, Ill		R. Kennicott	Do.
5450	1	Toledo, Ohio	—— —, 1861	Dr. Trembley	Do.
7008	2	Portage Lake		Wm. Dickinson	Do.
7038	4	Grass River, Madrid, N. Y			Do.
7061	3	Cleveland, Ohio		Dr. J. P. Kirtland	Do.
7057	2	Detroit, Mich		Captain Gunnison, U. S. A	Do.
7042	1	Tuscumbia, Ala			Do.
7015	3	Tarboro, N. C		J. L. Bridger	Do.
12071	6	Mount Carmel, Ill	—— —, 1881	L. M. Turner	Do.
4058	1	Arkansas River, near Fort Smith.		G. Shumard	Do.
12761	1	Morehouse Parish, La	1882	B. H. Broadnax	Do.
13390	2	Montgomery, Ala	1882	T. S. Doran	Do.
	49				

GENERAL SERIES.

12079	1	Mount Carmel, Ill	Nov. —, 1881	L. M. Turner	Alcoholic.
7059	1	Saint Louis, Mo		Dr. George Englemann	Do.
3967	1	Cook County, Ill		R. Kennicott	Do.
7060	1	Root River, Racine, Wis		Prof. S. F. Baird	Do.
7041	1	Tyree Springs, Tenn		Prof. R. Owen	Do.
7057	1	Detroit, Mich		Captain Gunnison, U. S. A	Do.
7054	1	Lake Michigan, Mich		Rev. A. C. Barry	Do.
7006	1	Isle Royal		Major Whittlesey	Do.
7058	1	Columbus, Ohio		Dr. Wormley	Do.
4058	1	Arkansas River, Ark		Dr. B. F. Shumard	Do.
7053	1	Meadville, Pa			Do.
7141	1	(?)			Do.
7061	1	Cleveland, Ohio		Dr. J. P. Kirtland	Do.
7049	1	Columbus, Ohio		Prof. L. Lesquereux	Do.
3980	2	(?)		(?)	Do.
14460	1	Detroit, Mich		(?)	Do.
	17				

NECTURUS PUNCTATUS Gibbes.

Journal of the Boston Society of Natural History, 1853, VI, p. 369.

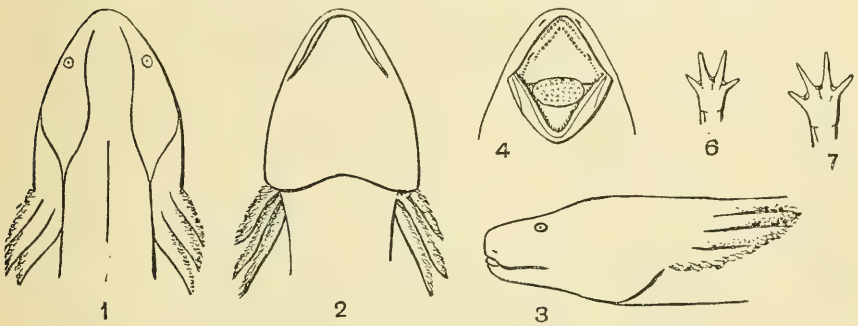


FIG. 4. *Necturus punctatus*, No. 11813, Charleston, S. C., natural size.

The general appearance of this species is quite different from that of the *N. maculatus*, and this is supported by several structural characters.

The animal is not common in collections, and there are but four in the National Museum.

The general form is much like that of the *N. maculatus*, but the muzzle is different. Instead of being depressed or even concave above, and rather wide, it is pinched at the sides, so as to be rather elevated at the end, and to have a truncate profile. The head is wide in proportion to its length, the two measurements being about equal. The length of the tail is the same as in *N. maculatus*, twice its length marking a point posterior to the eye. The limbs are not quite so long as in the *N. maculatus*, the space between them, when they are appressed to the sides, equaling twice the extent of the anterior leg, which is little longer than the posterior. In the specimens in the Museum the body is decidedly compressed, and there is a distinct median dorsal groove. These characters are less marked in the *N. maculatus*.

The upper lip is more pendulous than in *N. maculatus*, or perhaps such an appearance may be ascribed to an elevation of the premaxillary border, in accord with the more elevated muzzle. The nostrils are a little closer together than in the larger species, the distance between them equaling half the interorbital space, instead of two thirds. However, in one of the four specimens this space measures two-thirds that between the orbits. The branchial processses are relatively considerably longer than in *N. maculatus* in all the specimens, and they are more acuminate in form. Their length considerably exceeds that of the muzzle in front of the eye. In *N. maculatus* they are usually shorter than this length; in two or three specimens, however, they are as long as in the *N. punctatus*. There are but two branchial fissures. The width of the head enters 5.6 times the length of the head and body together.

The numbers of the teeth furnish distinctive characters for this species. They are: Premaxillaries, 6–8; vomeropalatines, 8–9; pterygoids, 6. Thus while the pterygoids are as numerous as in *N. maculatus*, the numbers of the other teeth are reduced. There are eleven dentaries and three splenials in the lower jaw. The posterior nares are a longitudinal slit opposite the space between the vomeropalatine teeth and the pterygoids. The tongue is short and rounded, and extensively free in front. The phalanges of the anterior foot are 2–2–3–2. The metacarpals are connected by a slight web to their distal ends. The middle toes are equal, and the external and internal ones are equal. The posterior phalanges number 2–2–3–2, and the digits are all unequal, and are very slightly webbed at the base.

The skin is entirely smooth. The lateral folds number fourteen, as in *N. maculatus*. The muscular part of the tail has a wide, free, dermal border above and below. The former is more slender than in most specimens of the *N. maculatus;* but this character does not always hold good. There are five cloacal papillæ, with the three anterior finely fringed, as in *N. maculatus*.

Measurements of No. 11813 (type).

	M.
Total length	.171
Length to end of vent	.120
Length to opposite groin	.099
Length to opposite axilla	.035
Length to opposite anterior branchia	.023
Length to opposite eye	.006
Width of head at eyes	.015
Width of head between eyes	.010
Greatest width of head	.017
Length of anterior limb	.019
Length of posterior limb	.018
Depth of tail at middle	.014

In life the colors are very indistinct and admirably adapted for concealment in water. In alcohol they fade to light brown or slate color; the lower surfaces paler. There are no spots or darker markings of any kind, but in life there are numerous minute white punctæ scattered on the sides and upper surfaces.

As may be seen from the accompanying list of specimens, the range of this species is quite limited. It has not been found out of the rivers of North and South Carolina.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
11813	1	S. Santee River, S. C.	— —, 1850	Dr. L. R. Gibbes	Alc. type.
12594	2	Wilmington, N. C.	Mar. —, 1882	Donald McRae	Alcoholic.
7014	1	Charleston, S. C.		(?)	Do.

URODELA.

Duméril pt. 1804; Cope, 1887; *Pseudosauria* pt. De Blainville, 1816.

No intercalary, supraoccipital, nor basioccipital bones. O. maxillare present; prefrontale present (with one exception); vomero-palatina present, not approximated to usually present pterygoidea; orbitosphenoid large, not reaching palatal surface; mandible with teeth on the dentale.

Body of proatlas coössified, with the atlas forming the odontoid process of the latter. Cervical vertebræ without vertebrarterial canal. No rudimental centra or intercentra. Ribs with two, frequently closely approximated, heads.

No median sternal elements. Coracoid bone rudimental. Sacral rib well developed. Pubes represented by a single cartilaginous plate, which sometimes contains a median osseous center. Ischia in mutual contact throughout their length. No obturator foramen. Femur with distinct great trochanter.

The stapes has no connection with the suspensorium in the adult except in the Cryptobranchidæ and Amphiumidæ. It is connected with the suspensory cartilage, which is continuous with the quadrate cartilage, in the latter families, and in the young of other Urodela. The

ceratohyal is either free at its posterior extremity, as in the Proteida, or in the more typical forms it joins the quadrate cartilage by direct articulation or by ligament.

The hyoid apparatus has a very uniform character in the various families, excepting in the Cryptobranchiidæ, Amphiumidæ, and Cœciliidæ, where it is quite different. In the typical forms it is constructed as follows: Its suspensor is, as usual, the ceratohyal, which is undivided. This is connected with a median basal piece, the first basibranchial, by a segment, generally slender, the hypohyal. Sometimes this piece does not touch the ceratohyal. From the posterior lateral border of the basibranchial there originates on each side a rod, the first ceratobranchial, which is continued after a joint, as the first epibranchial. From a process which originates between the bases of these, on the superior side of the basibranchial, there originates on each side of its posterior extremity another rod, shorter than the first, the second ceratobranchial. In some genera (Hynobiidæ) there is attached to the distal extremity of this rod a second one, continuous with it, the second epibranchial. The second basibranchial is separated from the first, and is situated far posterior to it, not far in advance of the coracoid bones. It is better ossified than most of the rest of the hyoids, and was called the thyroid bone by Cuvier. That it is the distal extremity of the second basibranchial is shown by the fact that it is continuous with the first by a median rod in the larvæ. (Plates 15, 25, 26, 36, 37.)

The important differences displayed by the different forms of the hyoid in the Urodela may be tabulated as follows.

I. Median and lateral elements distinct.
  a. Two ceratobranchial pairs.
    Ceratohyals undivided; epibranchials, first and rarely second present. *Pseudosauria* Blv.
    Ceratohyals divided; epibranchials, 2, 3, and 4 present. *Trematodera* Dum.
  aa. One pair of ceratobranchials.
    Ceratohyals undivided; epibranchials, 2, 3, and 4 present. *Amphiumoidea* Cope.
II. Lateral elements continuous across middle line.
  No median elements. ..... *Apoda* Oppel.*

The Trematodera, Amphiumoidea, and Apoda contain one family each, viz: the Cryptobranchidæ, Amphiumidæ, and Cœciliidæ. The value of the differences separating them is diminished by the fact that in the larvæ of the Pseudosauria the 1, 2, 3, and 4 epibranchials are present, and the ceratohyal is frequently divided (*e. g*, *Chondrotus tenebrosus*, Plate 25, fig. 1).

The subordinate differences presented by the families and genera are indicated under their respective heads.

The Urodela, excepting the Apoda, have limbs. The toes number from two in both feet to five in the posterior foot, and four in the anterior foot. No Urodele agrees with the extinct genus Eryops (Cope), from the

* Oppel, 1811, not *Apodes* of Linnæus (in fishes); *Pseudophidia* De Bl., 1816.

Permian beds of North America, where there are five toes in the anterior foot. In the carpus there is at least one intermedium, except in some Salamandridæ and Pleurodelidæ,* where it is united with the ulnare. Centrale always present. The carpalia are five in Cryptobranchus and Amblystoma, and three in Plethodon and Diemyctylus. In the tarsus there are three bones in the first row, a large fibulare and intermedium, and a small tibiale. There is one centrale, as in the carpus. The tarsalia number five, except that there are four in the Salamandridæ and Pleurodelidæ, where the carpalia are only three. The internal or first tibiale is not distal, but lateral in Amblystoma and Plethodon. It is distal in Cryptobranchus. (Plates 45, 46).

Development.—The eggs of Urodela are laid in the water or on land. In the former case they are attached singly or in small numbers to the leaves of aquatic plants. In the latter case they are laid in little concavities beneath stones or bark. In Desmognathus the albumen connecting them dries into threads, which hold the eggs together. One of the parents lies by and watches them. In the Amphiumoidea† and the Apoda‡ the female coils herself in a circle over the eggs.

In the growth of the larvæ the branchiæ and balancers are first developed, and afterwards the anterior limbs. The posterior limbs follow. Those spiracles or branchial fissures between the epibranchial bones which support the gills give passage for water from the pharynx. There are no internal gills such as are found in Anura. The branchial processes vary in form, but all terminate in fringes, in each of which is a vascular loop. The varieties displayed by larvæ of Urodela as compared with those of genera with permanent branchiæ are as follows: (Plate 2.)

I. Septa with bipinnate rami.
Rami with many thread-like fimbriæ.....*Siren.*

II. Septa with unipinnate rami.
A rudimental inner row of rami; fimbriæ thread-like.....*Proteus.*

III. Septa with simple rami.
A. Rami long, compressed; fimbriæ dependent from lower edge.
Fimbriæ thread-like, extending on both outer and inner face of process. *Necturus.*
Fimbriæ flat, long, chiefly confined to the lower margin of process. Larvæ of *Spelerpes ruber; S. bilineatus,* and *Gyrinophilus porphyriticus.*
Fimbriæ few, subclavate.....*Plethodon cinereus.*
AA. Rami long, narrow; bearing fimbriæ only on the side next the body.
Fimbriæ simple, flat, subequal.....*Amblystoma.*
AAA. Rami very short; fimbriæ extending on the vertical septa.
Fimbriæ in numerous rows on the edge of the septa; slender, unbranched. *Larva* of *Chondrotus tenebrosus.*

IV. Septa without rami.
Septa bearing flat, thread-like fimbriæ, which arise posteriorly, and are often divided. Larva from Simiahmoo, Washington Territory, probably of a *Chondrotus.*

* *E. g. Molge vulgaris* (Dugés), *Diemyctylus viridescens.*
† O. P. Hay, American Naturalist, 1888.
‡ Sarasin, Embryology of the Cœciliidæ.

In the development of the vertebræ all are first biconcave, or fish-like. The intervertebral cartilage ossifies later, and attaches itself to the centrum posterior to it, forming an opisthocœlous articulation. There are no procœlous vertebræ among Urodela.

The feet are first simple at the extremity (Plate 20, fig. 6), but soon become bifurcate (Fig. 5), or with two digits. This was first observed by Rusconi in 1821 in the European *Hemisalamandra cristata*. Professor Baird* first observed this in the *Amblystoma punctatum* in larvæ of 1.4^{mm} in length. The same has since been observed by myself in 1869,† and later by Götte‡ in his essay on the development and regeneration of the foot-skeleton in the triton; also by Strasser and by Hoy. In *Amblystoma punctatum* the numbers of digits succeed each other as follows: First stage, 2 before, hind limb none; second, 3 before, hind limb none; third, 3 before, hind limb 2; fourth, 3 before, hind limb 3. Sometimes the anterior digits are complete in number before the posterior foot appears, and we have combinations of numbers from 4—0 to 4—3, and 4—4 to the full number, 4—5, which is found in all specimens of 2.5^{mm} and upwards.

As already observed, the Batrachia are supposed to have been derived from the Dipnoi. Specimens of *Lepidosiren annectens* have been described§ which have the extremity of the limbs abnormably bifurcate, but the abnormality is perhaps in the direction of the evolution of digits. Dr. G. Baur believes that the third, fourth, and fifth digits have grown or sprouted successively in time from the external distal angle of the ulna and fibula, while the first and second are represented by the two original branches.‖

In the cranium a good many important changes occur before the bones appear.¶ Among the first of these is the division of the five simple transverse branchial cartilages into two segments each, epibranchials and ceratobranchials, or, in the case of the anterior arch, into ceratohyal and hypohyal. So the mandibular cartilage immediately anterior to the ceratohyal, divides into the superior quadrate, and the inferior meckelian or mandibular. A subsequent change is the fusion of the quadrate cartilage at its superior end with the trabeculum of its side, and with the pterygopalatine arch with the inferior end. (See Plate 48, figs. 7–9.) At this time the chordadorsalis has retreated till it is only present between the exoccipital cartilage below. When ossification commences, the vomers, palatines, and pterygoids are all distinct. Towards the end of the metamorphosis the former two unite, and the pterygoid separates from the palatine. Both these elements contract away from each other until they are widely separated, and the pterygoids are much

*Iconographic Encyclopædia, 1851.

†Proceedings Phila. Acad., p. 95.

‡1879.

§By Steindachner.

‖Beiträge zur Morphogenie d. Carpus u. Tarsus der Vertebraten, 1887, p. 67.

¶The facts as to the first stages of the skull of the larva of Amblystoma are derived from Dr. W. K. Parker, Philosoph. Transac. 1877, p. 529.

reduced in size. In some families the pterygoids never ossify, and disappear. An illustration of the late persistence of the osseous pterygo palatine arch is seen in the larva of *Chondrotus tenebrosus*. (See Plate 24.)

The *systematic arrangement* of the Urodela may be represented as follows:

I. Lateral and median hyoid elements distinct.

A. Two pairs of ceratobranchial bones; stapes connected with quadrate arch; no double hypopophyses. *Trematodera.*

No first epibranchial; no double hypopophyses of vertebræ; vertebræ amphicœlous; ceratohyal connected with quadrate by ligament only; vomeropalatine bones with teeth on the anterior margin; vestibule with membranous inner wall; no parasphenoid teeth.

Cryptobranchidæ.

B. One pair of ceratobranchial bones; stapes connected with quadrate arch; hypopophyses double. *Amphiumoidea.*

No first epibranchial, several others present; vertebræ amphicœlous; an ethmoid; scapular and pelvic arches present; ceratohyal connected with quadrate by ligament only; liver little sub divided.... *Amphiumidæ.*

C. Two pairs of ceratobranchials; stapes not connected with quadrate arch in adult; only the first and rarely second epibranchials present; vertebræ without double hypopophyses. *Pseudosauria.*

1. Vertebræ amphicœlous.

Vomeropalatine bones with teeth on the posterior margin; ceratohyal connected with quadrate by cartilage; no parasphenoid teeth; vestibule with osseous walls; carpus and tarsus ossified; an otoglossal cartilage; no second epibranchial element ..... *Amblystomidæ.*

Vomeropalatine bones with teeth on the posterior margin; no parasphenoid teeth; no otoglossal cartilage; a second epibranchial.

Hynobiidæ

Vomeropalatine bones with teeth on the posterior margins; parasphenoid teeth; vestibule with osseous walls; ceratohyal connected with quadrate by cartilage; no otoglossal cartilage; no second epibranchial; carpus and tarsus cartilaginous; no pterygoid.... *Plethodontidæ.*

2. Vertebræ opisthocœlous.

Vomeropalatine bones not sending processes over parasphenoid bone; ceratohyal connected with quadrate by cartilage; parasphenoid teeth; no postfrontosquamosal arch; carpus and tarsus cartilaginous ..... *Desmognathidæ.*

Vomeropalatine bones not produced posteriorly; parasphenoid teeth; no postfrontosquamosal arch; carpus and tarsus osseous..... *Thoriidæ.*

Vomeropalatine bones extended over parasphenoids in two dentigerous processes; no parasphenoid teeth; no osseous postfrontosquamosal arch; ceratohyal only connected with quadrate by ligament; carpus and tarsus osseous..... *Salamandridæ.*

Vomeropalatine bones extended over parasphenoid in two dentigerous processes; no parasphenoid teeth; an osseous postfrontosquamosal arch; ceratohyal only connected with quadrate by ligament; carpus and tarsus osseous ..... *Pleurodelidæ.*

II. Hyoid elements continuous across middle line. No distinct median elements. Stapes connected with quadrate bone. *Apoda.*

Vertebræ with double hypopophyses; an ethmoid bone; scapular and pelvic arches wanting; liver greatly subdivided ..... *Cœciliidæ.*

The Cæciliidæ are generally regarded as representing a distinct order, which bears the names Apoda or Gymnophiona. The definition given to this order by Mr. Boulenger* is: "No limbs; tail rudimentary. Males with an intromittent copulatory organ. Adapted for burrowing." Of these definitions none is of ordinal value. The tail in some species is distinct. The intromittent copulatory organ in *Dermophis mexicanus*, *Gymnopis proximus*, and *Herpele ochrocephala* is not an especial organ, but is merely the everted cloaca. The hard papillæ observed by Günther† in the *Ichthyophis glutinosus* are wanting in the above species. The protrusion of the cloaca is effected by two especial muscles, which are wanting in Amphiumidæ. As to limbs, their extremely rudimentary character in Amphiuma is well known. To regard their condition as indicating ordinal separation from the Cæciliidæ is not in accordance with our practice in similar cases in the Reptilia, as in the order Lacertilia.

I have endeavored to sustain the order Gymnophiona by the character of the fusion of the nasal and premaxillary bones found in the majority of the genera.‡ But Stannius§ shows that these bones are distinct in Ichthyophis. Huxley states (Anatomy of Vertebrate Animals, p. 155) that in *Ichthyophis glutinosus* a distinct bone nearly encircles the orbit. This he compares to the supra and postorbital bones found in the Stegocephali. But in Chthonerpeton, Cæcilia, Dermophis, and other genera, this bone forms part of the maxillary, so that it is not characteristic of the family, and may not be homologous with the bones which occupy the same position in Stegocephali. Wiedersheim calls it maxillary.

With these fact in view I have united‖ the Cæciliidæ with the Urodela, a proposition which I fully believe to be sustained by the evidence. *The Cæciliidæ is a family of Urodela, connected with the typical forms through the Amphiumidæ.*

Geographical distribution.—The distribution of the families of the Urodela and their contents is as follows: None exist in the Australian realm and, excepting some Cæciliidæ, in the Ethiopian realm. In the Neotropical they are restricted to the Central American and Mexican districts, with a few species in the northern Andes, and one reputed to be from the West Indian island, Santo Domingo.

The Cæciliidæ are more widely distributed, belonging especially to tropical regions.

* Catalogue of the British Museum, 1882, p. 88.

† Reptiles of British India (Ray Society), p. 441.

‡ American Naturalist, 1884, p. 26.

§ Zootomie der Amphibien, 1856, p. 44.

‖ American Naturalist, 1885, p. 244, note, and Proceeds. Amer. Philos. Soc., Feb. 1886 p. 442.

Families.	Palæarctic.	Indian.	Ethiopian.	Nearctic.	Neotropical	Total.
Cryptobranchidæ	1			2		3
Amblystomidæ	1	1		19		26
Hynobiidæ	8					8
Plethodontidæ	1			26	9	36
Desmognathidæ				3		3
Thoriidæ					1	1
Salamandridæ	12					12
Pleurodelidæ	13			3		16
Amphiumidæ				1		1
Cæciliidæ		5	6		21	32
Total	36	6	6	54	31	138

The temperate regions of the New World is, then, the home of the greatest number of species of Urodela, after which the temperate regions of the Old World follow.

The distribution of the families and their species in North America is as follows:

Families.	Regions.				
	Eastern.	Austroriparian.	Central.	Sonoran.	Pacific.
Cryptobranchidæ	2				
Amblystomidæ	12	6	1	1	8
Plethodontidæ	8	8			11
Desmognathidæ	3	1			
Pleurodelidæ	1	1			1
Amphiumidæ		1			
	26	17	1	1	20

The details of distribution are given under the family and generic heads.

Phylogeny—This order is probably of considerable antiquity, but no species positively referable to it is known from any pretertiary formation. In tertiary beds we have representatives of different types. The genus Chelotriton Pomel from the Miocene of Allier, France, has opisthocœclous vertebræ like most of the existing species of Europe, and has in addition an expansion of the neural spine of each vertebra, to which the epidermis was closely adherent, giving a row of rough plates down the middle line of the back. Heliarchon and Polysemia of Von Meyer are known from specimens from the Miocene beds of Germany. They have apparently the cartilaginous carpus and tarsus of the American genera. The Miocene of Switzerland has furnished the remains of a species, probably of Cryptobranchidæ, which has been referred to the genus Andrias by Tschudi. It is very much like Cryptobranchus.

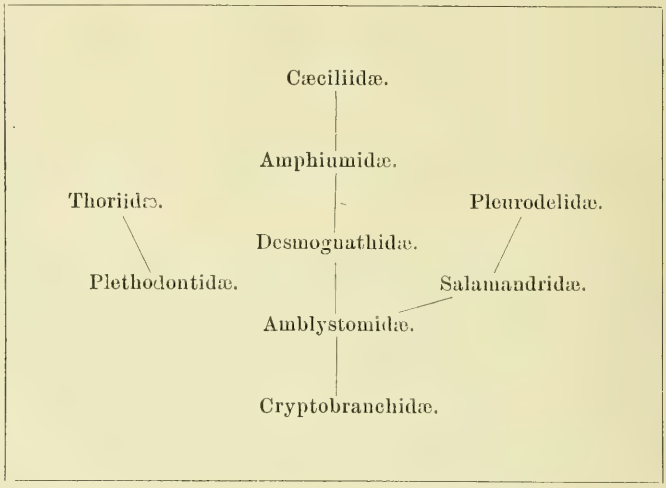
In older formations we have in the North American Laramie the genus Scapherpeton Cope, which may well belong to the Urodela, but the skull is unknown. In the Wealden of Belgium the genus Hylæobatrachus Dollo may belong to this order, but the skull is not yet well known.

The most primitive form of the existing Urodela is apparently Cryptobranchus.

Wiedersheim* (*l. c.*, p. 95) has attempted to trace the ancestry of the Cæciliidæ to the Stegocephali of the Carboniferous period, from which he supposes them to have arisen by a process of degeneration. He remarks that in order to demonstrate this proposition it is only necessary to discover a type with rudimental limbs which shall connect the two.

That the Cæciliidæ is a type which has resulted from a degeneration, I have also proposed,† but I have derived them from the Urodela rather than from the Stegocephali direct. They have, like Amphiuma, essentially the same cranial structure as the Urodela, which is widely different from that of the Stegocephali, in the absence of the intercalare, supratemporal, basioccipital and postorbital bones. And these characters are fully maintained in various genera of Stegocephali which have rudimental limbs. Amphiuma then is the annectant type with rudimental limbs which Dr. Wiedersheim sought for. The circumstance that his eyes were turned toward the Stegocephali indisposed him to recognize this fact.

The affinities of the recent families, which may be regarded as phylogenetic, may be represented as follows:



CRYPTOBRANCHIDÆ.

Vertebræ amphicœlous, without anterior double hypopophysis. Tail developed. Parietal and prefrontal bones embracing frontals, and meeting above orbits. Vestibule with internal wall membranous. No ethmoid bone. Carpus and tarsus cartilaginous. Vomeropalatine teeth on anterior border of bone of that name. Pterygoid bone present.

*Anatomie der Gymnophionen, Jena, 1879. †American Naturalist, 1885, p. 244.

Of this family but two existing genera are known, although it is quite probable that a third has left remains in the Miocene lacustrine beds at Oeningen, in Germany, which is known under the name of Andrias. The existing genera differ as follows:

Branchial fissure present..... *Cryptobranchus.*
No branchial fissure..... *Megalabatrachus.*

The *Megalobatrachus maximus* is found in Japan and eastern Asia as far southwest as eastern Thibet. It exceeds in dimensions the species of Cryptobranchus, which are exclusively North American, but has a great general resemblance to them.

The nearest approach to this family among other Urodela is made by the family of Amblystomidæ. The structural differences are, however, important.

CRYPTOBRANCHUS Leuckart.

Isis, 1821, p. 260. Boulenger, Catal. Batr. Grad. Britr. Mus., 1882, p. 81.
Abranchus. Harlan, Annals, Lyceum Nat. Hist. New York, 1825, I, p. 221.
Menopoma. Harlan, *l. c.*, p. 270; Tschudi, Batr., 96; Dum. Bibr., Eop. Gén., IX, p. 205.
Salamandrops. Wagl., Nat. Syst. Amphib., 1830, p. 209.
Eurycea. Rafinesque (teste Baird), Atlantic Journal, 1832, p. 121.
Protonopsis. "Barton", Gray, Catal. Batr. Grad. Brit. Mus., ed. I, p. 53.

In this genus the vomerine teeth form a regularly arched series, concentric with the maxillary series. The tongue is but little free, and that only round the edges. The columella of the stapes is cartilaginous, and is connected by a close articular contact with the quadrate cartilage and with the under side of the squamosal bone. The ceratohyal is connected by a ligament with the posterior side of the quadrate, with the intervention of an oval cartilage, which has the position of the stylohyal bone of fishes. The posterior extremity of the ceratohyal is not incurved, and is free from the skull. (Plate 48, fig. 3.)

The hyoid apparatus is quite characteristic. They have been already described so far as they define the suborder Trematodera. They resemble the Pseudosauria in having two ceratobranchials, but differ from them and resemble the Amphiumoidea in having no first epibranchial. This element may, however, be confluent with the first ceratobranchial, but no suture appears in very young specimens. The ceratohyals are divided transversely and the hypohyals are large. They are not in contact with each other or with the first basibranchial, as in other orders and suborders, but are separated by a pair of transverse elements, which are probably true basihyals. The first basibranchial appears to be interrupted at its middle, the anterior part remaining attached to the basihyals. No second basibranchial.

A broad cartilaginous plate rises from the basibranchial and supports the tongue. It resembles a good deal the otoglossal cartilage of the Amblystomidæ, with which it is probably homologous.* The second,

*This suggestion I owe to Dr. Galt.

third, and fourth epibranchials are present. Between the bases of the second and third is a rudimental third ceratobranchial. (Plate 15, fig. 4.)

The carpus in Cryptobranchus is somewhat variable in the typical species. The centrale carpi always separates the intermedium from the ulnare, thus reaching the ulna, while the centrale tarsi is always shut off from the fibula by the intermedium. (Plate 45, fig. 3.) There may be two centralia tarsi (Plate 46, fig. 3), as has been shown by Wiedersheim. There are four carpalia and five tarsalia, but the fourth and fifth tarsalia may be fused. (Plate 46, fig. 3.)

The bones of the extremities are simple, the femur being without the trochanter found in the Pseudosauria, and the humerus being without the condyles. The scapular arch is entirely cartilaginous, excepting the scapula, which is small. There is a large cartilaginous coracoid plate which overlaps that of the opposite side, and is deeply fissured transverse obliquely in front from the interior border, cutting off a narrow procoracoid. There is a cartilaginous sternum posterior to the coracoids. The pelvic arch has an osseous ilium, which is in contact with an osseous ischium on each side, which does not meet its fellow on the middle line below. The pubic region is represented by a large simple cartilage, which is produced into a style on the middle line anteriorly, as in the Pseudosauria.

In its visceral anatomy this genus resembles the Pseudosauria. The stomach is distinct, and there is a pyloric flexure. (Plates 6 and 52, fig. 4.)

There is one widely-distributed species of this genus, and probably a second, known only as yet from the upper waters of the Tennessee River, but the latter requires further investigation, as I have seen but a single specimen of it. The distinguishing features are the following:

Posterior digits free; tongue free in front, its superior surface thrown into plicæ; internal nares open ..... *C. allegheniensis.*

Posterior digits webbed, the external to the tip; tongue not free, covered with large closely-placed pappillæ; internal nares valvular ..... *C. fuscus.*

CRYPTOBRANCHUS ALLEGHENIENSIS Daudin.

(Plates 5–8.)

Cryptobranchus alleghenicnsis, Van der Hoeven, Tijdscher, v. Nat. Gesch. en Physiol. IV, p. 384, Pl. v A, f. 3–4, & v. B; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 81.

Salamandra alleghaniensis, Daud., Rept., viii, p. 231.

Salamandra gigantea, Barton, On *Siren lacertina.*

Molge gigantea, Merr. Tent., p. 187.

Cryptobranchus salamandroides, Leuckart, *l. c.*

Abranchus alleghaniensis, Harlan, *l. c.*

Menopoma alleghaniensis, Harlan, *l. c.*; Holbr., N. A. Herp., v, p. 95, Pl. 32; Dekay, N. Y., Faun. Rept., p. 89, Pl. 18, f. 44; Dum & Bibr., p. 207, pl. 94, f. 1; Wied., Nova Acta Leop.-Carol, XXXII, p. 133, Pl. 6.

Salamandrops gigantea, Wagl., *l. c.*
Eurycea mucronata, Rafin., *l. c.*
Menopoma gigantea, Tschudi, *l. c.*
Protonopsis horrida, Gray, Cat. Batr. Grad. Brit. Mus., ed. 1, p. 53.

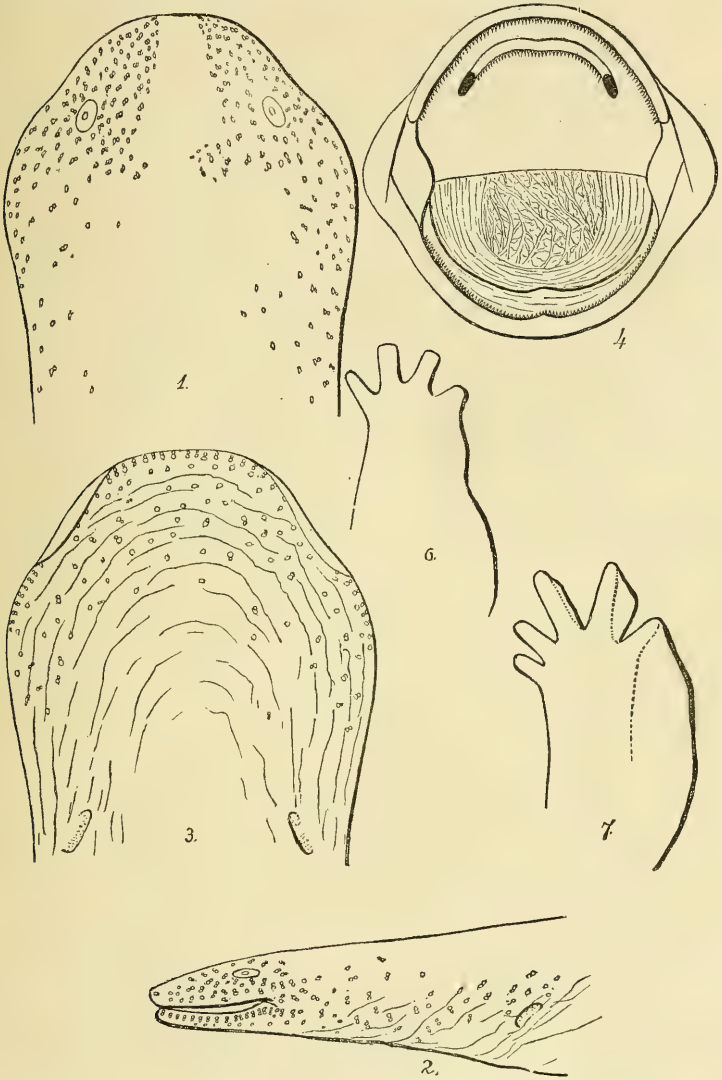


FIG. 5. *Cryptobranchus allegheniensis* Daud.; No. 9752. Pennsylvania; natural size.

Body moderately elongate and depressed; the limbs quite short. The tail much compressed, about one-half the length of the head and body. The neck wide; the head a little wider, plane above, flat and much depressed, with very short, wide, and rounded muzzle.

The nostrils are near the labial border, and look forwards. The space separating them is about half the interorbital width. The eyes are quite small, and are covered with a rather thin cornea, but are without dis-

tinct eyelids. They are oval in outline, the long diameter anteroposterior. They are widely separated from each other and are not far from the labial border. The jaws are equal in front, and the muzzle is perfectly flat. The upper lip is not pendulus except at its posterior end, where it is also thick. The free lower lip is decurved, and extends only about one-third the distance round the lower jaw.

The mouth is wide, and the rictus falls below the posterior canthus of the eye. The maxillopremaxillary arc of teeth extends to a point a little posterior to a line dropped from the posterior edge of the eye. The vomeropalatine series is quite close to the maxillopremaxillary, and extend about one half way as far posteriorly as the external row. At the middle of the arc it sometimes presents a convexity backwards for a short distance. At each of its extremities is situated the posterior nostril, which is an oval more or less open, and never a slit, as in the *C. fuscus*. Its position differs from that seen in *Amphiuma means* and *Necturus* in its being at the end of the row, and not external to it. The roof of the mouth is everywhere flat. The tongue is wide and is considerably free in front, the free border narrowing laterally and posteriorly. It nearly fills the floor of the mouth, leaving but a narrow space between it and the mandibular arc. Its surface is thrown into numerous elevated folds, which are thin, and generally anteroposterior in direction. They intercommunicate by lesser oblique folds, which with other delicate ridges form a net-work between the principal ones. In old specimens or badly-preserved ones the plicæ may be flattened or lowered.

The legs are quite short; when pressed to the side they are separated by a space equal to 1.25 the length of the anterior limb. The fingers are short and rather free, and the external one is considerably shorter than the internal one. The others are subsequal. An extensive fold of the skin extends from the axilla to near the extremity of the external finger, forming the posterior expanded border of the limb. It is most prominent at the lower part of the upper arm. The posterior toes are rather short, and are free from web as to the phalanges. The first is the shortest, and the second a little exceeds the fifth. The third and fourth are subequal, and, with the fifth, are somewhat depressed. This appearance is produced by a dermal wing on the external border, which increases in width from the third to the fifth, becoming very wide on the latter. It continues from the fifth toe on the hinder border of the leg to the base of the thigh, corresponding with the similar fold on the fore leg. The epidermis is not hardened into ungues in this species.

The skin is perfectly smooth, but is thrown into a longitudinal undulating fold on the sides between the fore and hind legs. This fold is obsolete in some specimens, apparently on account of the distension of the body with food or eggs. There are a shallow median dorsal groove and fourteen costal grooves. The latter are not distinct on the back or belly, and are best seen on the sides of the latter. The tail has a free dermal border on its superior edge, but none on the inferior edge, thus

differing from the species of Necturus. A groove along the side of the tail divides it into a superior and inferior portion, and a lateral wedge-shaped mass, covered with longitudinally folded skin, intervenes between the two for about one-third the length of the member. Dermal mucous pores are especially abundant on the head of this species. They generally appear in the middle of a low, elongate, dermal papilla, dividing it into two papillæ. These are closely placed in a triangular patch, of which the maxillary border forms the hypotenuse, a line extending backwards from the nostril parallel to the middle line, another side; and the other border transverse, passing about its own diameter posterior to the eye. But there are numerous other similar papillæ posterior to this patch, and on the sides of the anterior half of the neck. A series of double papillæ extends round near the border of the lower jaw, becoming obsolete on the symphyseal region. A conspicuous arched row of the same extends round opposite the inferior edge of the lower jaw; and between it and the superior row are numerous other pores and papillæ. A row of pores passes round within each arm on the sides of the thorax; and there are two rows on the sides, one above and the other below, the lateral fold. The upper row is continued on the wedge-like portion of integument, forming the middle of the basal third of the side of the tail.

The branchial fissure is half-way between the angle of the lower jaw and the shoulder. The vent is small.

Measurements of No. 9752.	*M.*
Total length	.480
Length from end of muzzle to end of vent	.319
Length from end of muzzle to line of groin	.275
Length from end of muzzle to line of axilla	.100
Width between nostrils	.013
Width between eyes	.029
Greatest width of head	.056
Width between axillæ	.045
Width at base of tail	.030
Depth of tail at middle	.0455
Length of fore limb from axilla	.054
Length of fore foot	.011
Length of hind limb	.061
Length of hind foot	.020
Length of lower leg	.026
Width between internal nostrils	.0245

The largest specimen (No. 10043) measures 545 mm.

The usual color is rather light lead-colored above and a still paler shade of the same below. There are indistinct darker spots on the surface above, only visible when the animal is in fluid. Sometimes these shades are represented by very distinct dark-brown spots (Nos. 4531, 7004). Some specimens have the ground color brown of a lighter hue (No. 7005), the dark spots being present or absent. Three specimens (No. 9205) are almost entirely black.

This species is distributed from western New York and Pennsylvania and the Great Lakes to Iowa, and south to Georgia, North Caro-

lina, and Louisiana. It is not yet known from Florida or Texas. A single specimen in the National Museum was taken in the Susquehanna River, Pennsylvania.

The "hellbender" is entirely aquatic in its habits, and is frequently taken by fishermen on their hooks. It is very tenacious of life, and is perfectly harmless. Its larval period must be of brief duration, since it has not been yet observed. The eggs are rather large, and are attached by two strong suspensors at opposite poles.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
10043	1	Susquehanna River			Alcoholic.
8229	1			Agricultural Department	Do.
7068	1	Allegany County, N. Y		Dr. Stevens	Do.
9204	1	Evansville, Ind			Do.
9205	3	Great Lakes			Do.
9444	6				Do.
9752	1	Pennsylvania	June 1, 1878	H. B. Wright	Do.
7005	3	Abbeville, S. C		Dr. J. B. Barratt	Do.
7055	1	Poland, Ohio		Prof. S. F. Baird	Do.
7069	1	Tyree Springs, Tenn		Prof R. Owen	Do.
9202	1	Hillsborough, N. C		Rev. M. A. Curtis	Do.
4531	4	Meadville, Pa		J. F. Thickston	Do.
5037	1	Georgia		Dr. W. L. Jones	Do.
3879	2	Prairie Mer Rouge, La		James Fairie	Do.
7004	2	Nolichucky, E. Tenn			Do.
13922	1	Des Moines, Iowa	1884	R. Ellsworth Call	Do.
9316	1	(?)		(?)	Do.
	31				

GENERAL SERIES.

7069	1	Tyree Springs, Tenn		Prof. R. Owen	Alcoholic.
7004	1	Nolichucky River, Tenn			Do.
9316	14	(?)			Do.
	16				

There is some variation in specimens in the relative distance of one nostril from the other and from the eye. In some specimens these distances are identical; in others the former is somewhat less than the latter, and the same measurement, usually one-half the width between the eyes, may enter it 2.25 times.

A local variety is seen in three specimens (No. 7005) from Abbeville, S. C. These are a light brown, much resembling the *C. fuscus*, but are spotted with a darker brown. The double papillæ are not visible on the superior surface of the head, and are faintly marked on the inferior aspect. The rows of pores are, however, as in *C. allegheniensis*, as are the tongue and internal nares. The digits are all more slender, and the dermal ala on the external toe and that of the elbow are much reduced.

Besides the generic character, the following differences may be observed on comparison of this species with the *Megalobatrachus maximus* of Asia. In the latter the tongue is not free, but is sessile, and without plicæ; head with rows of obtuse tubercles; sides and limbs without dermal folds.

CRYPTOBRANCHUS FUSCUS Holbrook.

Menopoma fuscum Holbrook, N. Am. Herpetology, 1842, v, p. 99.

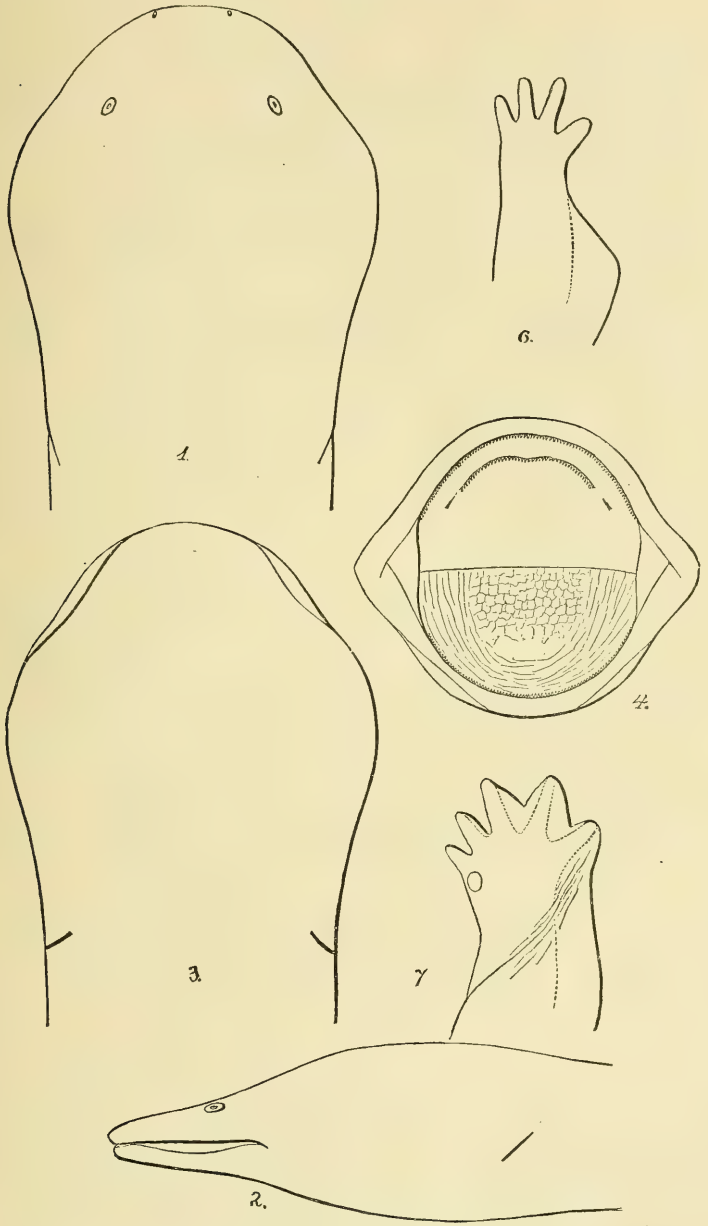


FIG. 6.—*Cryptobranchus fuscus*, Knoxville, Tennessee; natural size

Besides the characters already assigned to this species, the single specimen on which it rests differs from most of those of the *C. alleghe-*

niensis in the absence of the longitudinal dermal fold on the side, and of the papillæ on the upper surface of the head. In both these respects it agrees with some specimens from Abbeville, S. C. (No. 7005), already referred to. I do not attach much importance to the absence of the lateral folds, as distension of the abdomen from any cause would be apt to cause it to disappear. These two characters, however, with the brown color, supplement the three important ones given in the diagnosis, and confirm the propriety of recognizing the species. Nevertheless, the observation of other specimens presenting the same features will be necessary before the species can be regarded as fully established.

The head has the wide, flat form of the other species, with the very short and broadly rounded muzzle, but these characters are exaggerated. Thus the length from the end of the muzzle to the lines connecting the angles or canthus of the mouth enters the greatest width of the head four times and a fraction; while in the *C. allegheniensis* it is one-half the same measurement of the width of the head, or even a little longer. The shortness of the gape as compared with its width is also indicated by the fact that the canthus oris is below a point anterior to the anterior canthus of the eye in the *C. fuscus*, while in the *C. allegheniensis* the angle is below the posterior canthus of the latter. The eye is smaller than is usual in the *C. allegheniensis*, its long diameter entering the interocular space a little over seven times; while in the more abundant species it enters five times to nearly six times. The extremity of the maxillary series of teeth corresponds with the canthus of the mouth. The vomerines have only half as much length. The internal nostril is a slit, nearly closed, in line with the series of vomerine teeth at their extremity. I have not found it closed in this way in any specimens of the *C. allegheniensis*. The characteristics of the tongue form one of the strongest characters of this species. Its superior surface is covered with large truncate papillæ, so closely placed as to be everywhere in contact. They are only distinguished, as in the human tongue, by bending the surface. Nothing like this is known in the other species. Here the surface of the tongue is marked with longitudinal plicæ, separated by considerable intervals, which are themselves subdivided by smaller and lower plicæ, the general result being an appearance something like tripe. The width between the external nares is half of that between the orbits or the posterior nares.

The crypts of the skin of the superior surfaces are coarser than in the *C. allegheniensis*, especially on the posterior half of the head. The anterior half of the latter is smooth. No trace of the double papillæ is to be found on the superior surfaces, but they exist in the arched series round the lower jaw below the lip, as in the other species, but with this difference: the papillæ one above the other are not round, but short longitudinal keels, so as to be parallel to each other.

The fingers are entirely free, and the phalanges are, beginning on the inner side, 2, 2, 3, 2. The ala on the posterior edge of the upper arm is

well developed, and terminates just below the elbow. The toes come in the order of length as follows, beginning with the short inner, 1, 5, 2, 3, 4; and the phalanges, in the same order, are 2, 2, 3, 3, 2. The three external are ribbed from the tips; the notch between the third and fourth reaching the end of the first phalange, but between the fourth and fifth extending from tip to tip, with a very slight notch (easily enlarged by tearing); the legs are about as long as in *C. alleghaniensis*. When they are pressed to the side they are separated by a distance equal to one and a quarter times the length of the hinder leg. This measurement must be taken with some allowance, as the specimen has been coiled in strong alcohol, and its true form is not easily restored.

It is impossible to distinguish the true lateral folds. An estimate makes them equal those of the other species, fourteen. The tail has the usual form. Its superior outline rises from the base, and is convex, and consists partly of a thin dermal border. The extremity is thin, as is also the distal fourth of the inferior edge.

Measurements.

	M.
Total length	0.440
Length to end of vent	.295
Length to groin	.215
Length to axilla	.100
Length to line of canthus oris	.015
Length of anterior leg	.039
Length of anterior foot	.015
Length of posterior leg	.053
Length of posterior foot	.0245
Width between external nares	.012
Width between orbits	.025
Width of head	.051
Depth of tail at middle	.042

The color of this specimen is a rich chocolate brown; the inferior surfaces rather paler than the superior. No spots.

Catalogue number.	No. species.	Locality.	Donor.
.....	1	Knoxville, Tenn	Professor Mitchell.

AMBLYSTOMIDÆ.

This family is of particular interest among the Urodela, as furnishing connecting forms between the ordinary types of the order and those larger species which we suppose to be more characteristic of former periods of the earth's history. It also furnishes us with transitional conditions of characters which have been regarded as indicating very diverse origin and nature. The species are mostly of large size, and are probably confined to North America; perhaps a species exists in Farther India.

The characters which restrict the family are as follows:

No ethmoid. Palatine bones not prolonged over parasphenoids, bearing teeth on their posterior margins. Orbitosphenoid separated from proötic by membranous walls. Internal wall of vestibule osseous. Carpus and tarsus ossified. Vertebræ amphicœlous. Prefrontals and pterygoids present. Premaxillaries fully developed. Parasphenoid without dentigerous plates. An otoglossal cartilage; only one, the first epibranchial; second basibranchial isolated.

We may here observe the significance of the features defining this family. Two of the characters assigned are what I have termed morphic; that is, one has not been assumed after possession of the other, nor is it identical with the immature stage of the same. Such are the shortened form of the palatine bones, as compared with the posteriorly produced laminæ of the Salamandridæ, and the absence of dentigerous plates on the parasphenoid in the Plethodontidæ is a character of the same kind. Under such circumstances we infer that the families exhibit an ontogeny modified by cœnogeny.

The biconcave vertebræ constitute a persistence of a larval feature.

The presence of pterygoids has the same significance with reference to other families.

The ossification of the carpus and tarsus are characters in which this group develops beyond the larval condition which is permanent in the family Plethodontidæ.

Thus of eight characters two are morphic and six developmental; of the six, two are of advanced development and four of repressed development, as compared with other families.

The writer characterized this family nearly as above in the Journal of the Philadelphia Academy, 1866, 105. Dr. Hallowell proposed it in the same work, 1858, 337, but on insufficient characters. Many of the characters of the principal genus Amblystoma had been already pointed out by Professor Baird. The genera included by Hallowell were Amblystoma, *Xiphonura* Tsch., and Onychodactylus Tschudi. Gray had previously embraced the same genera with *Heterotriton* Gray, in his first section of the Plethodontidæ, which corresponds with this family. The writer in 1859 embraced Onychodactylus, Amblystoma, *Camarataxis* Cope, and Megalobatrachus Tschudi. In the above-cited essay of 1866 the genera are limited to the two first mentioned with *Ensatina* Gray.

The investigation of the subject which I gave in my monograph of this family, published in 1869, resulted in the following disposition of these supposed genera, Baird having already shown the identity of *Xiphonura* with Amblystoma. "*Heterotriton* is identical with Amblystoma. Megalobatrachus, the great salamander of Japan, I have determined to pertain to the Cryptobranchidæ. The genus *Camarataxis*, as will appear further on, was established on a larval character, permanent in some individuals it is true, but not permanent in any species. On the other hand, there is some probability that one or both of the species of Hynobius Tschudi from Japan enter the family, but this I am not

able to establish." The latter genus, together with Ranidens, Onychodactylus and Salamandrella from Asia, have been since referred to the Amblystomidæ by Boulanger, but I now find the hyoid apparatus to be quite different in the two groups.

Three genera of this family are known to me. Another has been distinguished on dental characters (Dicamptodon), but whether identical with or distinct from those I have seen I do not yet know.

I. Vomeropalatine teeth in a transverse line, which is straight or angulated and not much interrupted at the middle.
  Otoglossal cartilage forming a ring, attached posteriorly to the first basibranchial cartilage ..... *Amblystoma.*
  Otoglossal cartilage forming a subtriangular plate attached posteriorly to the first basibranchial ..... *Chondrotus.*
II. Vomeropalatine teeth in two series, separated by a wide interspace.
  Otoglossal cartilage not annular, free from the basibranchial, on which it moves; tail round ..... *Lingualapsus.*
  Tail compressed; dental series converging backward ..... *Dicamptodon.*

The species of these genera are all North American excepting the *Amblystoma persimilis* Gray of Siam.

AMBLYSTOMA, Tschudi.

Tschudi, Batr., p. 92; Baird, Journ. Ac. Phila.(2), I, 1850, p. 281; Gray, Cat., p. 34; Dum. & Bibr. IX, p. 101; Cope, Proc. Ac. Phila., 1867, p. 166; Strauch, Salam, p. 60; Boulenger, Cat. Batr. Grad. Brit. Mus., 2d ed., 1882, p. 38.
Xiphonura, Tschudi, *l. c.*, p. 95; Gray, *l. c.*; Dum. & Bibr., p. 161.
Salamandroides, Fitzing., Syst. Rept., p. 33.
Heterotriton, Gray, *l. c.*, p. 33.
Camarataxis, Cope, Proc. Ac. Phila., 1859, p. 122.
Pectoglossa, Mivart, Proc. Zoöl. Soc., 1867, p. 698.
Larval forms:
Siredon, Wagl., Syst. Amph., 1830, p. 209; Dum. & Bibr., p. 176.
Axolotes, Owen, Ann. and Mag., N. H., XIV. p. 23.
Desmiostoma, Sager, Penins. Jour. Medic., 1858, p. 428.

Vomerine series of teeth in the same line, though often interrupted.

Quadratojugal bone wanting. Premaxillary bones distant from each other, not embracing a fontanelle.

Tongue attached by its whole base, but with a narrow free margin on all but the posterior portion, capable of but a moderate protrusion.

The otoglossal cartilage forms a ring, which passes entirely round the circumference of the interior base of the tongue. It sends a process on each side near its base, which terminates above the ceratohyals without articulating with them.

Hypohyal cartilages slender, of moderate length. (Plate 26.)

Ceratohyal articulating by its abruptly recurved superior extremity with the posterior distal part of the quadrate. (Plate 48, figs. 8–10.)

Digits 4–5, free, not connected by natatory membrane.

A stratum of crypts more or less thickened on the parotoid region and along the superior lateral region of the tail.

A series of mucous pores round the orbit and for some distance anterior to it.

The second basibranchial element is transverse, generally angulated forwards, and is well ossified. The other parts of the hyoid apparatus that are ossified are the proximal portion of the ceratohyal, the anterior part of the first basibranchial, and the free extremity of the first epibranchial.

The larvæ are characterized by the long, slender processes of the three branchial laminæ, which bear the vascular fimbriæ, rather than the laminæ themselves, as in Chondrotus. The internal nostrils are confined between the maxillary series of teeth and the palatine arch, which is concentric with the former and near to it, and is continued backwards on each side in line with a similar series on the pterygoid bones. A relation of nostrils to palatine teeth similar to the above is permanent in Amphiuma, and one intermediate between it and the adult condition of Amblystomæ of groups III and IV characterizes Cryptobranchus.

The tail and back have a free dermal margin, but there is none on the limbs or digits. The tail is short and deep.

The following are some of the most readily observed characters which are assumed by the Amblystomæ at the period of their transformation: (1) The series of teeth on the splenial bone is shed; (2) the carpus and tarsus ossify; (3) the tail narrows and lengthens; (4) the branchiæ disappear; (5) the tongue enlarges and covers the floor of the mouth; (6) the pterygopalatine series of teeth becomes more nearly transverse; (7) brightly colored pigment is deposited in the chromatophoræ of the derm. These changes are stated in the order of their occurrence. But in some of the protean species this order is not exactly observed in all individuals, and in consequence of the assumption of one or the other character of maturity in advance of another the number of species has been supposed to be greater than it is. The same irregularity in the successional appearance of structures is well known in the earlier periods of embryonic life, as stated by Von Baer in the scholia of his Entwickelungs-geschichite. In the chick, different portions of the vertebral axis and the abdominal plates may or may not appear in the usual order of succession.

In Amblystoma the approximation of the period of reproduction to that of transformation varies with the species, and it is evident that the closer this approximation, under the above principle of variation, the more protean will the species be. As we know from the experiments of Hogg, Duméril, and others that metamorphosis is greatly hastened or delayed by the conditions of temperature and light, what would not be the effect on individuals of such a protean species of a change of topographical situation, such as the elevation or depression of the land? And I have no hesitation in saying that if the peculiarities of series of individuals of *A. tigrinum*, in the respects above enumerated, were permanent, they would characterize those series as species as completely as any that zoölogists are accustomed to recognize. For the evidences on this head, see the discussion of this species below.

The experiments of Hogg, above alluded to, are as follows, as given by him in the Annals and Magazine of Natural History.

He placed a number of impregnated ova of frogs in vessels arranged at regular distances from the light in a cave. The lessening degrees of light were of course accompanied by a corresponding but much less rapid decline in temperature. The resulting effects on the metamorphosis may be tabulated as follows:

Month.	Day.	Mean, Fahrenheit. 69°	56°	53°	51°
3	11	Egg	Egg	Egg	Egg.
	20	Larva free	*	*	*
	25	*	Larva free	Larva free	Larva free.
	31	*	*	*	*
4	10	Larva very large	Larva large	Larva large	Larva small.
	22	Metamorphosis complete.	Metamorphosis complete.	*	*
8	11				
	28			Metamorphosis complete.	*
10	31				Metamorphosis complete.

Other experiments, which will not be quoted now, are equally conclusive as to the effects of light and heat on their process. The distinction between maturity, or adult age, and complete development must be borne in mind. The former condition is attained when the ova are fitted for impregnation and the spermatozoöids are capable of accomplishing that result. Development may or may not advance much beyond this period. As one or more periods in the life of every species is characterized by a greater rapidity of development (or metamorphosis) than the remainder, so in proportion to the approximation of such a period to the epoch of maturity or reproduction is the offspring liable to variation.

The great difference between the different species and between individuals of the same species in this respect, may be illustrated by the following comparison between the size of the animals at the time of losing the branchiæ, so far as known, and that to which they ultimately attained:

Species.	Size at loss of branchiæ.	Average full size.
	In. Lin.	*In. Lin.*
Amblystoma jeffersonianum	1 5.75	6
Amblystoma punctatum	1 10	6 6
Amblystoma conspersum	1 10.5	2 7.5
Amblystoma opacum	2 2	3 9.5
Chondrotus texanus	2 1	?
Chondrotus microstomus	2 3.5	4
Amblystoma talpoideum	3*	3 9.5
Chondrotus paroticus	3 7.5	7 2.5
Amblystoma tigrinum	3 7†	8
	8 9.5	9
Chondrotus tenebrosus	5 6	8
	9 9	11

*Perhaps too large. †Not smallest.

In this connection it is desirable to ascertain how far characters distinguishing undoubted species fall into the line of successional changes common to all the species, as answer to this question would solve an important part of the inquiry as to the origin of species. We can not go into it exhaustively at this time, but direct attention to these characters in the synoptic table. The following are developmental characters which distinguish known species: (1) The direction of the palatine series of teeth; (2) the length of the body and tail, as compared with the width of the head, is greater in large and old individuals of *A. tigrinum;* (3) the widening of the muzzle and greater separation of the external nares; (4) the spotted as distinguished from the uniform coloration.

Characters to which no such relation can be assigned: (1) The number of costal folds, whose interspaces correspond with the vertebræ; (2) the number of phalanges.

Baird, in the first synopsis of this genus published, enumerates eight species; Gray in 1850 catalogues ten, after we exclude some species of other genera erroneously included. Duméril, likewise including species of other genera, gives five true Amblystomæ. Hallowell, 1858, increased the number to sixteen. In my monograph of this genus, published in 1867, the species described numbered eighteen, six new ones being added. Dr. Boulenger, in the Catalogue of the British Museum, second edition, published in 1882, gave the number as seventeen, including a Siamese species. In the present work thirteen species are admitted, one of which is the Siamese species *A. persimilis*, after the subtraction of nine species placed in the genera *Chondrotus* and *Linguælapsus*. For the study of this genus the collection of the Smithsonian Institution is unequaled. Probably the second best collection existing, that of the Academy of Natural Sciences of Philadelphia, has also furnished its numerous types, and several species mostly described by the late Dr. Edward Hallowell.

Synopsis of species.

I. Series of teeth extending along the external fissure of the internal nares. Plicæ of tongue radiating from its posterior portion. Parotoid glands not forming an ovoid distinct mass. Four phalanges in fourth toe.*

A. Costal grooves, ten.

a. Vomerine series, three.

Head broad; width 3.5 to groin; muzzle contracted; external nares much closer than internal; palatine series convex backwards; tail short, compressed; blackish-brown, gray specked. ..... *A. talpoideum.*

B. Costal grooves, eleven.

α Vomerine series three.

β No, or one indistinct plantar tubercle.

Middle series transverse or concave to behind posterior margins of nares; width of head in specimens of 3 inches, greater than one-fourth length to groin; in adults, 4.7 times; black above, with gray cross-bands. *A. opacum.*

* *Vide* an exception under *A. tigrinum.*

Teeth as in the last; width of head in small specimens, 3.5 to groin; in adults, 4.5 times; a strong dorsal groove and longer tail; blackish above, with a series of round yellow spots on each side of the back. *A. punctatum.*

. Median series of teeth convex, advancing beyond posterior margin nares; width of head much less than one-fourth length to groin; tail short, no dorsal groove; lead-colored, with an inferior lateral and usually superior series of small irregular yellowish gray spots.. *A. conspersum.*

$\beta\beta$ Two distinct plantar tubercles;

Median series of teeth straight, nearly divided; external nares much closer together than internal; width of head more than one-fourth length to groin; muzzle very short; tail much compressed; blackish above, with large, irregular, yellow spots, confluent on sides; below yellow ..... *A. bicolor.*

$\alpha\alpha$ Vomerine series four.

Teeth in four series, which form an obtuse angle directed forwards; width of head, 3.6 times in length to groin; length from muzzle to axilla equal length from axilla to groin; tail nearly as long as head and body; dark brown, with a dark brown band on side ... *A. copeanum.*

C. Costal grooves, twelve;

α Larger species, with two distinct plantar, tubercles and mucous pores on the side of the muzzle.

β No canthus rostralis; tail shorter than head and body; chin not projecting.

. Vomeropalatine tooth series with the median portion presenting a very obtuse angle forwards, rarely straight, sometimes with the lateral portions separated; brown, with large yellow spots of larger or smaller size..... *A. tigrinum.*

Muzzle broad obtuse; dark brown, with vertical yellow spots on sides; teeth in four distinct series, in a nearly transverse line. *A. trisruptum.*

$\beta\beta$ Canthus rostralis distinct; chin projecting.

External nares nearer together than internal; muzzle obtuse; head small, width 5 times to groin; front convex; tail longer than head and body; vomerine teeth in one series, slightly convex forwards; yellow, with irregular brown bands above..... *A. xiphias.*

$\alpha\alpha$ Smaller species; the mucous pores not extending beyond the orbits; teeth in three series; no, or one indistinct plantar tubercles.

External and internal nares equidistant; vomerine series nearly transverse; width of head, 4.5 to 6 times in length to groin; length of eye, 1.75 to 2.5 times in width between anterior canthus of same; lead colored to brown or black, with or without pale or distinct lateral spots..... *A. jeffersonianum.*

Nares equidistant; width of head, 5 times to groin; muzzle contracted; length of eye, entering 1.66 times in width between canthus of same, once to nostril; median dental series angulated forwards; digits long; brown or lead colored, usually a broad gray band on vertebral line of tail and body expanding on occiput; sides, dark reddish-brown. *A. macrodactylum.*

Muzzle wide; width of head entering length to groin 4 times; tail long as head and body to groin; digits short; black, upper surfaces bright yellow ..... *A. epixanthum.*

These species are distributed as follows: One, the *A. persimile* Gray, is said to be an inhabitant of the mountain regions of Siam. The others are all North American. One species only, the *A. tigrinum*, extends

southwards on the Mexican plateau as far as the City of Mexico. The remaining species are distributed as follows:

EASTERN REGION.—*A. opacum; A. punctatum; A. conspersum; A. bicolor; A. copeanum (?); A. tigrinum; A. xiphias; A. jeffersonianum.*

AUSTRORIPARIAN REGION.—*A. talpoideum.*

CENTRAL REGION.—*A. tigrinum; A. trisruptum.*

PACIFIC REGION.—*A. tigrinum; A. macrodactylum; A. epixanthum.*

As but one specimen of the *A. copeanum* is known, little can be said of its distribution.

AMBLYSTOMA TALPOIDEUM Holbrook.

Gray, Catal. Batr. Grad. Brit. Mus., 1850, p. 36; Duméril & Bibron, Erp. Gen., VIII, p. 109; Cope, Proceeds. Acad. Phila., 1867, p. 172; Strauch, Salam., 63; Boulenger, Catal. Batr. Grad. Brit. Mus., II ed., 1882, p. 40.

Salamandra talpoidea Holbrook, N. Amer. Herp., V, 73, Pl. 24.

Shortest, stoutest, and most clumsily formed of all the terrestrial *Amblystomata*. Character of skin as to glands pits, etc., much as in *A. punctatum* and *opacum*. A row of large pores on the head, interior to the eye and nostrils, extending anterior to the latter. This passes behind and beneath the eye, reaching forward nearly to the nostril; a patch on the cheeks above the lateral groove and another below it, probably extending forward along the lower jaw.

The head is very broad, and large, and is wider than the body anterior to the constriction at the neck. Its width is about equal to the distance from snout to gular fold (thus wider than long), and is contained about $3\frac{1}{2}$ times to the groin. The eyes are superior and rather small, separated anteriorly by nearly three lengths of the orbit; about one orbit from the nostrils, which are separated about $1\frac{1}{2}$ orbits. The muzzle is rather angular. The upper jaw is visible beyond the lower when viewed from below.

The body is short, squat, and depressed. There are 10 costal grooves on the side.

The tail is contained about $1\frac{1}{2}$ times in the rest of the animal. It is much as in *A. opacum*, but higher, though without a crest.

The digits are rather long and slender, scarcely different from those of *A. opacum*.

The palatine teeth are in a transverse series of three sections. The middle section is not interrupted along the median line. In the type it is slightly concave anteriorly, scarcely reaching to the inner line of the inner nares, and behind the range of the lateral sections, which begin a little interior to the outer line of the nostrils. The middle and lateral sections are separated by the width of the inner nostril. In another specimen the middle patch is nearly straight; in another, composed of two arcs concave anteriorly.

The tongue is thick, fleshy, and adherent, though the edges are free at the sides; less so at the tip. Its width is not more than half that of the head. The papillose portion is separated posteriorly by the exten-

sion forward of the plain basal portion of the tongue, although there is no groove, and exhibiting two prominent cornua to the tongue proper. The papillose ridges are longitudinal and nearly parallel.

In alcohol this species is a light brown above, paler beneath, irregularly sprinkled, blotched, and marbled with silvery or plumbeous gray, of a lichen-like character. Specimens when alive show the ground color to be a dark brownish or liver black, more livid on the sides, and perhaps lighter beneath; everywhere sprinkled with the silvery-gray dots of larger size on the back. The upper part of the tail is of a purer brown than elsewhere, and is bordered by a series of obscure blackish spots; seen also near the lower margin. A few similar dusky spots appear scattered on the back. The iris appears to be a dark brown without metallic luster.

A series of specimens from Prairie Mer Rouge, Louisiana, is quite similar. Some of them appear to have just completed the change from the tadpole state, and the tail is higher, more compressed, and somewhat crested; the toes, shorter, flatter; the papillose folds of the tongue more indistinct.

Measurements.

	Inches.
Length from snout to transverse line of mouth	.30
Length from snout to gular fold	.55
Length from snout to groin	1.90
Length from snout to behind arms	2.30
Length from snout to end of tail	3.80
Length of tail	1.50
Width of head	.52
Length of fore-arm	.46
Length of hind leg from knee	.56
Extent of hind legs	1.70
Greatest length of tail	.31
Greatest width at same place	.15

I found this species abundant in the high valley in southwestern North Carolina in which the French Broad River takes its origin from mountain streams. Thence it extends through the southern Atlantic and Gulf States to and including Louisiana, west of which it has not yet been found. It is not aquatic, but lives in damp places below logs and stones.

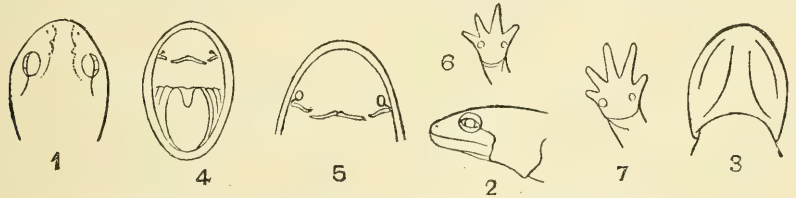


FIG. 7.—*Amblystoma talpoideum*. No. 3879. Prarie Mer Rouge, La.

No. of line.	Catalogue number.	No. of spec.	Locality.	From whom received.
1	3906	5	Liberty County, Ga	Dr. Jones.
2	3879	6	Prairie Mer Rouge, La	I. Fairie.
3	3972	1	Near Cairo, Ill	R. Kennicott.

AMBLYSTOMA OPACUM Gravenhorst.

(Plates 19–21.)

Amblystoma opaca, Baird, Journ. Ac. Phila. (2) I, 1850, p. 283; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 35, 1850; Hallowell, Journ., Phila. Acad., IV, 351.

Salamandra opaca, Gravenh., Ueber d. Zoöl. Syst., p. 431, and Delic., p. 75, Pl. 10; Dum. & Bibr., p. 66.

Salamandra fasciata, Green, Journ. Ac. Phila. I, 1818, p. 350; Holbr. N. A. Herp., V, p. 71, Pl. XXIII; Dekay, N. Y., Faun, Rept., p. 77, Pl. 17, fig. 40.

Amblystoma fasciatum, Dum. & Bibr., p. 105, Pl. 101, fig. 5.

Amblystoma opacum, Cope, Proc. Ac. Phila. 1867, p. 173; Strauch, Salam., p. 63; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 40.

Body swollen, thick, cylindrical, depressed; skin perfectly smooth, although under a lens everywhere showing minute simple pores or pits connected with the glands, which are seen everywhere on the body and tail, except, perhaps, on the lower part of sides, belly, and beneath the head; on the tail, however, they are most developed on the upper half. There are no regular patches of more conspicuous pores on the head and parotoids, as seen in *A. punctatum*.

Head rather broad, depressed, its greatest width about $\frac{3}{4}$ the length from snout to gular fold, and about $\frac{2}{3}$ the distance to insertion of hind legs. Axial length of mouth half that to gular fold, which is interrupted on the nape; a constriction behind the angle of the mouth, with a lateral groove (or ridge) connecting the two as in *A. punctatum*. Distance from snout to gular fold not quite $3\frac{1}{2}$ times in that to insertion of hind leg. The eyes are moderate; the pupil circular. The general relation much as in *A. punctatum*.

Body nearly cylindrical, but decidedly depressed. No indication of a dorsal furrow. Eleven well-marked costal furrows including the inguinal. There are about four pelvic furrows; those on the base of the tail are distinct anteriorly, but gradually become fainter.

The tail is oval or subelliptical in cross section, though without any indication of a keel. It is nearly cylindrical at base, though slightly compressed, becoming more and more so to the pointed tip. It is thicker above than below, and measured from behind the anus is contained $1\frac{1}{2}$ times in rest of the length. The lateral groove on the tail is less distinct than in *A. punctatum*.

The digits are linear, depressed, but without any indication of web or margin. The third or longest finger is one-third the distance from its tip to the elbow (contained three times). The lateral ones are quite short. The fourth toe is longest, and contained $2\frac{1}{2}$ times in the distance from its tip to the knee; the 3, 5, 2, 1 are successively shorter, or the fifth and second are about equal. The distance between the outstretched toes is contained about once and two-sevenths in the length from snout to behind anus.

The tongue is thick and fleshy, as in *A. punctatum*, though larger in proportion, and filling the mouth more. The teeth are in one transverse

line, in three series, much as in *A. punctatum*. The central is a double arc. The lateral series are not so far forward, or pass more obliquely backwards, so that their extreme end is even behind the convexity of the central series, not anterior to it. The lateral series is about half the length of the central, with a decided interval.

In alcohol the general color is a livid black. There is a dorsal series of transverse light slate-colored bands, which widen at each end into a V on the back, but are more linear on the tail. These vary in number; about seven on the body and as many on the tail; sometimes more or less; sometimes confluent with those before and behind them; sometimes interrupted in the middle. They do not descend one third the depth on the sides, being confined abruptly and well defined to the dorsal region. There is a similar patch on the snout.

Measurements.

	Inches.		Inches.
Total length	3.80	Length to tail	2.35
Length of mouth	.30	Length of tail	1.50
Length to gular fold	.53	Width of head	.45
Length to fore leg	.60	Length from elbow	.45
Length to hind leg	1.90	Length from knee	.55

The principal difference in form and structure between this species and *A. punctatum* are seen in the absence of any dorsal furrow, and a less prominence of that on the side of the tail. The limbs are more feeble, the head narrower, the tail shorter, etc.

In specimens from Prairie Mer Rouge, 4033 ? the body is thicker and more clumsy, the legs weaker, the toes shorter than in Pennsylvania specimens. The teeth, too, appear more transverse, and there is little or no interval between the middle and lateral combs.

This species is found in drier ground than is congenial to most salamanders. I have taken it in the sandy regions of New Jersey and Delaware.

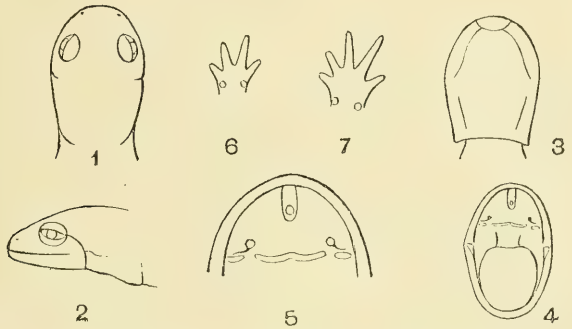


FIG. 8. *Amblystoma opacum* Gravenhorst. Gloucester, Va.

RESERVE SERIES.

Catalogue number.	No. of specimen.	Locality.	When collected.	From whom received.	Nature of specimen.
5268	3	Riceborough, Ga		Dr. W. L. Jones	Alcoholic.
4877	2	Norfolk, Va			Do.
9191	2	Kinston, N. C	—— 187	J. W. Milner	Do.
9289	2	Moulton, Ala			Do.
4100	3	Southern Illinois		R. Kennicott	Do.
4087	8	Prairie Mer Rouge, La		James Fairie	Do.
10892	7	Wheatland, Ind	Apr. —, 1881	Robert Ridgway	Do.
12051	10	Mount Carmel, Ill	Nov. —, 1881	L. M. Turner	Do.
4085	5	Lancaster, Ohio		Prof. L. Lesquereux	Do.
8979	2	Kinston, N. C	—— —, 1873	J. W. Milner	Do.
3981	1	New York			Do.
4920	1	Florida		T. Glover	Do.
3954	2	Texas		Prof. E. B. Andrews	Do.
12598	4	St. Jerome Creek, Md	Feb. —, 1882	E. N. Walker	Do.
3941	1	Abbeville, S. C		J. B. Barratt	Do.
13555	1	New Bedford, Mass		W. Nye, jr	Do.
3933	1	Tyree Springs, Tenn		Professor Owen	Do.
4018	1	New Orleans, La		N. O. Acad. Nat. Sci	Do.
3932	13	Carlisle, Pa		Prof. S. F. Baird	Do.
3949	1	Kemper County, Miss		D. C. Lloyd	Do.
3964	1	Racine, Wis		(?)	Do.
3958	1	Aux Plains River, Ill		R. Kennicott	Do.
3953	1	Salem, N. C		J. T. Linebach	Do.
	73				

GENERAL SERIES.

8347	1	Kinston, N. C	—— —, 1873	J. W. Milner	Alcoholic.
3751	3	Gloucester, Va		C. Mann	Do.
4087	85	Prairie Mer Rouge, La		Jas. Fairie	Do.
3928	2	Anderson, S. C		—— Daniel	Do.
3939	3	Georgia		J. Le Conte	Do.
3948	1	Tarboro, N. C		J. L. Bridger	Do.
3927	8	Gloucester, Va		(?)	Do.
4008	2	Columbus, Ga		Dr. Gesner	Do.
14484	1	....do		....do	Do.
3943	1	Meadville, Pa		J. F. Thickston	Do.
3924	6	Georgia		Dr. J. Le Conte	Do.
3962	1	Ripley, Ohio		—— Hay	Do.
	114				

AMBLYSTOMA PUNCTATUM Linn.

(Plates 14–18, 25, figs. 4, 5; Plate 48, fig. 10.)

Amblystoma punctatum, Cope., Proc. Ac. Phila., 1867, p. 175; Strauch, Salam., p. 63; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 41.

Lacerta punctata, Linn., S. N., I, p. 370.

Lacerta maculata, Shaw, Zool., III, p. 304.

Salamandra venenosa (Bart.), Daud. Rept., VIII, p. 229; Holbr., N. A. Herp., V, p. 67, Pl. 22.

Lacerta subviolacea, Barton, Amer. Phil. Trans., VI., p. 108, Pl. 4 fig. 6.

Salamandra subviolacea, Harlan, Journ. Ac. Phila., V, p. 317; Dekay, N. Y. Faun., Rept., p. 74, Pl. 2, fig. 36.

Amblystoma subviolaceum, Tschudi, Bar., p. 92.

Amblystoma carolinæ, Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 35; Gray, Proc. Zoöl. Soc. 1853, p. 11.

Amblystoma punctata, Baird, Journ. Ac. Phila. (2), I, p. 283; Hallowell *l. c.*, IV, 1858, p. 351.

Amblystoma argus, Dum. & Bibr., VIII, p. 103.

No. 3950 ♂. Body swollen, stout, cylindrical. Head depressed. Skin entirely smooth, though pitted with pores, which are most numerous on

the tail. Of these there is a patch of larger ones on the parotoid region, and another on the top of the head inside of the orbits and extending anteriorly in a straight line towards the nostrils and passing backwards semicircularly behind the eye. A double row around the edge of the lower jaw; a pair on each outer costal space along the side of the body, and a row on each side of the top of the tail; the latter indicated generally by a whitish dot.

Head broad; depressed; width nearly equal to distance from snout to gular fold, and nearly one-fourth the distance to insertion of hind legs. Length of mouth along axis of body half distance from snout to gular fold, which is nearly continuous across the nape. There is a constriction behind the angle of the jaws, interrupted above and below, and a furrow connecting the two along the parotoid region and extended in a lateral line to the orbit. Distance from snout to gular fold contained $3\frac{1}{2}$ times in distance to insertion of hind legs (four times in another specimen).

The eyes are moderately large; the length of the orbit contained $4\frac{1}{2}$ times in distance from snout to gular fold; about once in distance from the nostrils, and about once in the distance between the two nostrils; nearly twice in distance between the anterior extremities of the orbits.

Body nearly cylindrical, perhaps slightly depressed, and swollen a little in the middle; on each side are eleven costal grooves, including inguinal and axillary ones; all strongly marked and nearly continuous above and below; the axillary is, however, usually quite inconspicuous; four more of these furrows to behind the anus, where the last is confluent with the first caudal furrow; these become less and less distinct to near the middle of the tail. There is a slight groove down the middle of the back.

The tail is oval in section, the larger end of the oval below; becoming more and more compressed to the tip, without indication of any ridge. There is a lateral indentation along the whole length, which is about equal to the distance from the base to the snout. In alcoholic specimens the tail is bent or curved, sometimes upwards, sometimes down, sometimes laterally.

The digits are nearly cylindrical, or slightly depressed, without web or margin. The third or longest finger is contained about $2\frac{1}{2}$ times in the distance to the elbow. The second finger reaches to the last articulation; the fourth to the penultimate.

The fourth toe is longest, contained $2\frac{1}{3}$ times in the distance to the knee; the third, second, fifth, and first successively shorter. The distance between the outstretched hind toes is rather more than $1\frac{1}{3}$ the length to behind anus.

The tongue is thick, fleshy, and attached, although free at the edges except behind; it is about two-thirds the width of the upper jaw, nearly orbicular, though the outline of the papillose portion is a little emarginate behind. It almost seems as if the tongue were capable of closing round an object in its center, as in the hollow of the hand.

The transverse line of teeth is in three parts or combs; a central about two-fifths the width of the head, and separated from the lateral by a slight interval. The central patch is nearly straight in its middle, but the ends curve a little forwards, and continuously with the lateral portion of the line which forms a curve concave backwards, bounding the orbit. The inner edge of the posterior nares marks the extent of the central row of teeth. The lateral comb of teeth is about half the length of the central.

The color of the specimen described is, in alcohol, of a dark liver brown above, abruptly light olivaceous beneath. On each side of the back is a series of nearly circular rounded spots about the size of the orbit, about three on each side of the head, eight or nine on the body, and as many on the tail, where they are sometimes confluent. These spots are white in alcohol, but yellow in life. Along the sides and more sparingly beneath are some scattered, quite small whitish spots, not very conspicuous. The legs are of the color of the under parts, not of the upper; they show some of the small light spots seen on the sides.

Measurements.

	Inches.		Inches.
Total length of 3950	6.50	Length of tail behind anus	3.10
Length of mouth	.40	Width of head	.65
Length to gular fold	.82	Arm from elbow	.60
Length to groin	2.80	Hind leg from knee	.80
Length to behind anus	3.40		

In the preceding paragraph I have described a specimen from Abbeville, S. C., as a locality nearest to that whence the original of Linnæus's description was obtained. An examination of a large series of specimens from different localities shows certain differences, which, however, are not of a character to indicate specific separation.

The external appearance of the skin varies considerably with the strength of the alcohol used for preservation, and probably with the season when captured. The animal, when alive, is perfectly smooth and lustrous, and readily exudes a large quantity of a white milky juice from the upper half of head, body, and tail, or from the dark-colored portion. This is due to the presence of glands closely implanted in the skin, the pores of which are sometimes quite inconspicuous; sometimes very distinct. On the tail they are much largest and deepest, and the lateral groove marks their inferior boundary, being there implanted vertically. When these pores are very full of their milky juice and the alcohol is very strong the contraction of the skin between the mouths of these pores gives more or less the appearance of rounded, thick-set granules, of rather large size. This also gives rise to an apparent depression of the digits, the skin forming quite a margin.

The proportions of the body vary slightly. The tail is generally not so long as the rest of the animal, the groin being more usually nearer

the middle point of the axis. Younger specimens appear to have shorter tails.

There is considerable diversity in the curve of the transverse series of palatine teeth. In nearly all more northern specimens the central row is formed of two arcs, concave anteriorly, more or less continuous with the lateral, which are anterior and convex anteriorly. The two central arcs are continuous at their inner ends, forming an inverted angle on the axial line. Sometimes, however, as in most of the specimens from Prairie Mer Rouge, this central angle is wanting, and there is only a single arc or curve, concave anteriorly. In the type specimen described this central row of teeth is nearly or quite straight (which is quite apt to be the case in very large ones), while in one specimen of No. 4684 it is convex anteriorly. The transverse extent of this middle line of teeth varies. Sometimes there is quite an interval between it and the lateral, while in 3930, from New York, they are continuous without appreciable interruption.

There are no very great variations in the pattern of coloration. Generally the outer surface of the limbs is colored like the back, in which case there are one or more large, rounded light spots. The under parts are generally dark bluish; the sprinkling of small white specks on the sides and beneath varies considerably in prominence. The large dorsal spots are always nearly circular, and vary in number, generally only one series on each side.

In living specimens from Carlisle, Pa., the iris is dark brown, without metallic color, scarcely distinguishable from the pupil. The color of the animal above is a deep anthracite black; beneath, dull livid. On each side the dorsal line is a series of large, nearly circular, gamboge-yellow spots, somewhat symmetrically disposed. These vary from 10 to 20 from head to tail, and sometimes are larger than the eye; usually about its size. On the sides and beneath are sparingly scattered small bluish-white specks. The spots, both yellow and bluish-white, are sometimes found on the legs.

In younger individuals the yellow spots are brighter and the black ground deeper.—S. F. B.

Professor Baird (Iconographic Encyclopædia, 1851,) thus describes the reproduction of this species:

Early in April, or towards the end of March, large masses of gelatinous matter may be observed in ditches, pools of water, or mountain streamlets, which on closer inspection will be found to consist of a number of hollow spheres, about a quarter of an inch in diameter, embedded in or combined together by a perfectly transparent jelly. Within each sphere is a dark object, a spheroidal yolk, which in the course of some days becomes considerably elongated and exhibits signs of animation. Omitting, as unsuited to our pages at present, any account of the embryonic development of the animal, we resume its history at the time when its struggles have freed it from the shell of the sphere in which it

was inclosed. At this time it is about half an inch in length, and consists simply of head, body and tail, the latter with a well-developed fin, extending from the head and anus to the extremity of the body. Respiration is performed by means of three gills projecting from each side of the neck, of very simple construction, however, and with but few branches. The absence of limbs is compensated by the existence of a club-shaped appendage on each side of the head, proceeding from the angle of the mouth, and representing the cirri observed in some adult salamanders. By means of these appendages the young salamanders are enabled to anchor themselves securely to objects in the water. In the course of a few days a tubercle is seen to form on each side, just behind the head and under the gills, which elongates, and finally forks at each end, first into two, then three, and at last into four branches, thus exhibiting the anterior extremities, with the four fingers, which latter, in the larva, are very long. Before the fore-legs become completely formed those behind sprout out in a similar manner, with first three, then four, and finally five toes. During this time the gills have increased in the number of branches, and finally exhibit a beautiful arborescent appearance, in which the circulation of the blood can be distinctly seen by means of a simple lens. (See plate 16.)

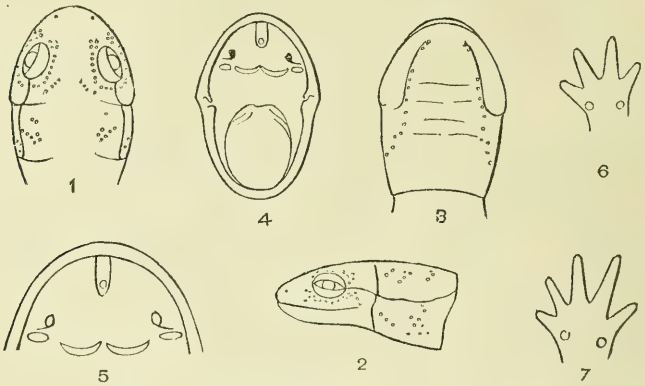


FIG. 9.—*Amblystoma punctatum*. Hampton, Va.

RESERVE SERIES.

Catalogue number	Number of specimen.	Locality.	When collected.	From whom received.	Nature of specimen.
4730	1	Whitfield County, Ga		A. Gephart	Alcoholic.
5270	4	Riceborough, Ga		Dr. W. L. Jones	Do.
8769	3	Belleville, Ill	Sept. —, 1874	Dr. A. Reuss	Do.
9188	1	Chicago, Ill		Sweeny	Do.
4399	1	Between Indianola and El Paso, Tex.		Col. J. D. Graham, U. S. Army.	Do.
4912	1				Do.
9190	2	Halifax, Nova Scotia		Dr. Gilbert	Do.
10893	1	Wheatland, Ind	Apr. —, 1881	Robert Ridgway	Do.
3926	6	Carlisle, Pa		Prof. S. F. Baird	Do.
3950	3	Abbeville, S. C		Dr. J. B. Barratt	Do.
3927	5	Gloucester, Va			Do.
3930	2	Allegany County, N. Y		Dr. Stevens	Do.
4098	10	Cook County, Ill		Dr. R. Kennicott	Do.
4084	2	Grand Coteau, La		J. Varden	Do.
4077	2	Fort Dawson, Red River, Ark.		Dr. L. A. Edwards, U. S. Army.	Do.
4086	1	Virginia			Do.
3938	6	Racine, Wis		Prof. S. F. Baird	Do.
3947	8	Carlisle, Pa		do	Do.
3965	10	Prairie Mer Rouge, La		James Fairie	Do.
3986	1	Cleveland, Ohio		Dr. J. P. Kirtland	Do.
12054	1	Mount Carmel, Ill	Nov. —, 1881	L. M. Turner	Do.
3961	3	Summerville, N. Y		(?)	Do.
3934	6	Carlisle, Pa		Prof. S. F. Baird	Do.
4886	1	Mount Joy, Pa		I. Stauffer	Do.
3944	1	Centre County, Pa		S. Brugger	Do.
3963	5	Meadville, Pa		(?)	Young.
3946	50	Carlisle, Pa		Prof. S. F. Baird	Alcoholic.
14485	1	Halifax, Nova Scotia		Dr. Gilpin	Do.
14494	1	Westport, N. Y	1885	Mrs. F. L. Lee	Do.
4686	1	Cleveland, Ohio		Dr. Kirtland	Do.
3936	1	Quebec		R. Nettle	Do.
3925	2	Saint Louis, Mo		Dr. G. Englemann	Do.
3942	3	Knoxville, Tenn		Professor Mitchell	Do.
3929	2	Westport, N. Y		G. W. Baird	Do.
3786	1	Cleveland, Ohio		Dr. Kalland	Do.
3905	62	Prairie Mer Rouge, La		James Fairie	Do.
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AMBLYSTOMA CONSPERSUM Cope.

Proceed. Acad. Nat. Sci. Phila., 1859, 123; 1867, 177; Strauch, Salam., p. 63; Boulenger, Cat. B. G. Brit. Mus., ed. II, 1882, p. 42.

This in one of the smallest species of the genus, and though less stout than the two preceding, is more so than the *A. jeffersonianum*, which it resembles in general features.

Skin everywhere smooth. In some specimens only a series of pores may be traced along the superciliary region and in a line to near the nostrils; several are on the parotoid region. The skin of the body is remarkably free from visible pores, while, as usual, the superior part of the tail is thickly studded with them.

The head is a broad oval, its width making the length to the groin 4.5 times or a little more, and is a little over three-fourths distance to gular fold. Eye fissure equal length to nostril, and 1.75 times between anterior angles, and a little more than distance between nostrils. The last distance is a little less than that between inner nares. Posterior canthus of eye a little anterior to canthus oiris; anterior canthus opposite middle of upper lip from anterior point. Muzzle longer than chin.

Furrows behind the orbit inconspicuous, but present. Costal grooves

eleven. Tail short, everywhere compressed, measuring from its origin (at end vent) to axilla or to gular fold. No marked dorsal groove.

The limbs are short; the digits long and slender. When appressed the fingers reach to the heel, or beyond bases of toes. Digits subcylindrical; anteriorly, third longest, then 2, 4, 1; posteriorly, 4, 3, 2, 5, 1. Two small tubercles on edges of sole. Expanse of outer toes equal from end muzzle to posterior canthus of eye.

Teeth in three patches, the median longest, commencing opposite inner margin of nares, and convex to between nares, or nearly so, in one specimen. Tongue longer than broad, the laminar portion prolonged in two lateral bands posteriorly.

Measurements.	Lines.
Length from snout to gular fold	4.60
Length from snout to groin	16.25
Length from snout to end arms	19.3
Length from snout to end tail	31.9
Length of mouth on median line	3
Length of fore-arm and hand from elbow	3
Length of leg and foot from knee	5
Width of head	3.7

General color above leaden, below pale leaden, the latter usually bounded by the line of the limbs, but in one specimen rising as high as the line of the eye. Lower parts of sides and sides of tail more or less varied with small whitish spots, the former often in a regular line. A similar line on the upper part of the sides is present in some specimens; in others wanting. The end of the muzzle is sometimes pale marbled.

Eight specimens of this species before me confirm its validity in every respect. Specimens of the developed young of both *A. opacum* and *A. punctatum* are of considerably smaller size, and maintain their peculiar colorations and a greater width of the head, etc.

From the appended localities from which it has been sent the range is seen to be extensive.

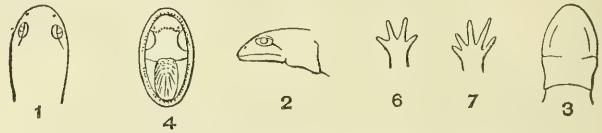

FIG. 10.—*Amblystoma conspersum.* No. 3934. Carlisle, Pa.

U. S. NATIONAL MUSEUM.

No.	No. spec.	Locality.	Donor.
3934	3	Carlisle, Pa	S. F. Baird.
3918	1	....do	Do.
		PHILADELPHIA ACADEMY MUSEUM.	
	1	Charleston, S. C	Dr. Holbrook.
	2	Liberty County, Ga*	John Le Conte.
	1	Chester County, Pa†	E. D. Cope.

* Specimen described. † Type.

AMBLYSTOMA COPEANUM Hay.

Proceedings U. S. National Museum, 1885, p. 209, Pl. XIV.

The head is large, somewhat wider than the body, and flattened; the body short, and the tail long and compressed. The skin is for the most part smooth, but everywhere, as seen under a lens, is pitted with the openings of the cutaneous follicles. Of these, there are a few enlarged ones in a band surrounding the orbit and extending forward to the nostril. Others are found above the angle of the jaw, and a few still larger ones on the posterior border of the parotoid region. The prominent keel and the whole tip of the tail are so richly provided with enlarged pores as to present a granulated appearance.

The width of the head is somewhat greater than that of the body. It is possible that the breadth and flatness of the head have been exaggerated somewhat by the injuries that it has received; but this can be true only to a very slight extent. The breadth is about the same at the angle of the jaw and the corner of the mouth. From the former point the head tapers backward, the outline being concave to its posterior border, where it is suddenly constricted into the neck. From the corners of the mouth the head tapers forward to nearly opposite the nostrils, beyond which it is rapidly rounded to form the snout. The width of the head is a little less than the distance from the snout to the gular fold, and is contained in the distance from the snout to the groin 3.6 times. The distance to the gular fold is contained in the distance to the groin 3.2 times. The depth of the head, on a line joining the angles of the jaws, is a little less than one-half its width. The gular fold does not overlap, as it does in some species. It may have done so in life, but manipulation of the skin fails to restore an overlapping fold. The upper jaw projects beyond the lower. Eyes of moderate size. External nares small; their distance apart somewhat less than the width of the interorbital space.

The tongue is not notably different from that of *A. tigrinum*. The teeth are arranged in four series, which together form an inverted V, the angle of which is very obtuse. The limbs of the V, as seen with the unaided eye, appear nearly straight, and are seen to extend beyond the internal nares along their external fissure. Examination with a lens proves that the inner series are each slightly ~ shaped, and so disposed as to make the angle of the V rounded off. The outer series on each side is nearly as long as the corresponding inner series; is plainly separated from it, and nearly straight or slightly concave on the posterior side. Inner nares more distant than the external. The body is somewhat depressed, but has not the swollen appearance presented by *A. opacum*. The distance from the snout to the axilla is just equal to that from the axilla to the groin. There are eleven well-marked costal grooves. There is a median furrow, not deep but distinct, beginning on the occiput and running along the back, deepening on the sacral region, and ending over the middle of the vent, at the commencement of the caudal crest.

The cloacal region is considerably swollen, and is broad and rounded, or slightly emarginate behind. The distance from the groin to the posterior end of the vent in this species is greater proportionally than in any other of the genus so far as I have been able to determine. It is contained in the distance from the snout to the groin but $3\frac{1}{6}$ times.

The tail is equal in length to the distance from the snout to the beginning of the vent. It is much compressed and rather high. It has a well-developed keel or crest, which begins immediately over the cloaca and extends to the tip of the tail. The keel is sharp above, and is bounded below on each side by a shallow groove. Inferiorly the tail is broadly rounded for its anterior third or more, and is traversed by a median longitudinal groove. The remainder of its lower border is compressed to a sharp edge. A transverse section of the tail, taken just behind the cloaca, would form approximately an isosceles triangle whose base would be about one-half its height. One-third of the distance back toward the tip the height of the tail is three times its thickness.

The limbs are well developed. The posterior are a little longer, somewhat stouter, and the foot broader than the same limbs of a specimen of *A. tigrinum* that measures the same distance from the snout to the end of the vent. They are also fully as long as the same limbs of a specimen of *A. punctatum* that measures from snout to the end of the vent three-fourths of an inch more than the specimen I am describing. The toes are flat, much like those of *A. tigrinum*, perhaps not so broad, while they are not so slender as those of a specimen of *A. punctatum* now before me. They are provided with a narrow marginal and basal membrane. There are two distinct plantar tubercles.

Measurements.

Length:	Inches.	Lines.
From snout to end of tail	5	8
From snout to gular fold	0	8.5
From snout to line joining axillæ	1	1.5
From snout to groin	2	3
From snout to end of vent	3	0
From end of vent to tip of tail	2	8
From axilla to groin	1	1.5
From groin to end of vent	0	8.5
Width of head at angle of jaw	0	7.5
Distance between anterior canthi	0	4.6
Interorbital space	0	3.25
Greatest height of the tail	0	5
Thickness of tail at highest point	0	2
Length of whole fore-leg	0	11
Lower arm and hand	0	7.5
Length of third finger	0	2.5
Hinder limb, total length	1	0.05
Lower leg and foot	0	9
Free portion fourth toe	0	3
Expanse of outstretched hinder limbs	2	5
Distance between external nares	0	2.6
Distance between inner nares	0	3.6

Proportional dimensions.

	Times.
Muzzle to gular fold:	
In distance from snout to groin	3.2
In distance to end of vent (nearly)	4.2
Fore-arm and foot:	
In distance to groin	3.6
In distance to end of vent	4.7
Lower leg and foot:	
In distance to groin	3
In distance to end of vent	4
Width of head:	
In distance to groin	3.6

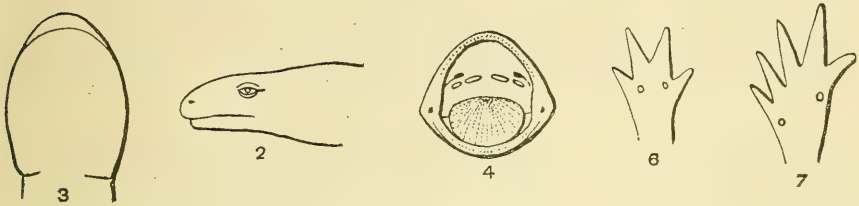

FIG. 11. *Amblystoma copeanum* Hay, natural size; copied from Hay.

The color is dark brown, almost black, above, brownish yellow below Between the fore and hind legs the light color of the belly mounts up on the sides to a level with the upper surfaces of the limbs. The middle of the belly is of a duskier hue than its sides. Pectoral, inguinal, and pubic regions slightly brighter yellow than the sides of the belly. Head above like the back, below like the other lower parts. Just behind the symphysis of the lower jaw are indications of a bright yellow spot. The upper half of the tail is not so dark as the back, the lower half duskier than the belly. The limbs below and in front yellowish, as other lower parts. Feet, especially above, dark.

This species must be compared with *A. bicolor* and *A. tigrinum*. The last belongs to the group which has twelve costal grooves. *A. tigrinum* has the internl nares no more widely separated than are the outer; the limbs of the vomerine V are decidedly concave, and the inner series of teeth are about twice the length of the outer. It is also a rather long-bodied species, the distance from the snout to the axilla being contained in the distance from the snout to the groin nearly 2.4 times, while in *A. copeanum* the latter distance is but twice the former. Indeed, this form differs from all others, in the shortness of the body, or the equality of the distances from snout to axilla and from axilla to groin. *A. bicolor* approaches it most nearly, but this species differs further in having no traces of the yellow spots so characteristic of that form. *A. copeanum* has also a broader and more depressed head, a more compressed tail, and longer limbs.

A. bicolor is described as having the palatine teeth in three entirely transverse series; as having a very short muzzle, and as being more or less spotted. A comparison of some of the dimensions of the two spe-

cies is necessary. The type of *A. bicolor* now in the museum of the Academy of the Natural Sciences of Philadelphia furnishes the measurements found in the first column.

Measurements.	A. bicolor.	A. copeanum.
	In. Lin.	*In. Lin.*
Length from snout to gular fold	0 9.75	0 8.5
Length from snout to axilla	1 2.5	1 1.8
Length from snout to groin	2 7.2	2 3
Length from snout to end of vent	3 2.3	3 0
Length from axilla to groin	1 4.5	1 1.15
Length of lower leg and foot	8.8	9
Width of head	8.75	7.5
	Times.	*Times.*
Fore-arm and foot into distance from snout to groin	4.6	3.6
Lower leg and foot into distance from snout to groin	3.54	3
Whole anterior limb into distance from snout to groin	$3\frac{4}{5}$	$2\frac{5}{11}$
Whole anterior limb into distance from snout to vent	$4\frac{1}{2}$	$3\frac{3}{11}$

The above table of comparative measurements shows that *A. bicolor* has, in comparison with *A. copeanum*, a longer and still broader head; in spite of this, a distance from the axilla to the groin greater than that from the snout to the axilla, a much shorter pelvic region, and shorter fore and hind limbs.

Found at Irvington, near Indianapolis, April 7, 1885, by Mr. George H. Clarke.

The specimen on which the description is based was found dead and somewhat mutilated. The injury that it has suffered does not, however, in any way obscure the characters of the species, amounting, as it does, only to a loss of the entire left fore-limb and slight fractures of a few of the bones of the anterior part of the head.

I have not seen this species, and know it only from the description and figures of Professor Hay. I have copied the greater part of the former in the preceding paragraphs. It is evidently a distinct species, characterized among other things by the shortness of its body. In coloration it is about identical with the *Amblystoma jeffersonianum fuscum*.

AMBLYSTOMA BICOLOR Hallowell.

Proc. Ac. Phila., 1857, p. 215; Cope, *eod. loc.*, 1867, p. 178; Strauch, Salam., p. 63; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 42.

In the type specimen of this species the usual superorbital and lateral frontal series of large pores are not discernible. In a second specimen they are well marked. In the former the skin is quite smooth, with eleven lateral grooves, and the folds of the throat and side of the head not strongly marked. The head is broad and obtuse, entering the length of the groin 3.75 times. The front convex in profile, containing the length of the fissure of the eye in its width between anterior canthus of same 2.75 times. The same measure is a trifle less than the

distance from same to nostril and one and a quarter the distance between the latter. These are much closer together than the inner nares. Distance between outer margin of nares equal length from end muzzle to midinterorbital space.

Dorsal line with a faint groove. Tail much compressed, equal from end vent to canthus oris. Body stout and heavy. The limbs are stout and the digits not elongate or depressed. The appressed limbs overlap by the length of the toes. Two well-marked palmar tubercles. Third and fourth toes nearly equal; fifth a little longer than first.

Tongue large, disciform, not emarginate behind. Palatine teeth in three entirely transverse series, the interruption taking place considerably inside the line of the nares. The teeth themselves are in numerous rows on each of their bony crests, presenting a brush-like arrangement. Median series notched behind.

Measurements.

	Inches.	Lines.
Length from end muzzle to gular fold	0	9.75
Length from end muzzle to groin	2	7.2
Length from end muzzle to end vent	3	2.3
Length from end muzzle to end tail	5	10.05
Length of mouth (straight)	0	6.1
Length of fore-arm and foot	0	6.75
Length of lower leg and foot	0	8.8
Width of head	0	8.75

Color above, olive brown; below, yellowish, olive shaded in the middle. The inferior yellow rises on the sides as short blotches; above them are several ill-defined yellowish spots. Parotoid region yellow, with a distinct black vertical bar. Limbs brown, cross-banded; tail yellow, with brown spots.

The above description is taken from the type from Beesley's Point, N. J., in the Museum Academy Philadelphia. Another specimen (4692) from the same locality, in the National Museum, differs in two important particulars: The palatine teeth are not brush-like, but are confined to the crest of the ridge, and the tail is a little longer than the head and body. The muzzle is rather longer and the mucous pores more numerous. It may belong to another species, as the *A. tigrinum*, which it much resembles, but its eleven costal folds are a notable peculiarity. The *A. bicolor*, though nearest the *A. tigrinum*, appears distinct, after a careful scrutiny of several individuals.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4692	4	Beesley's Point, N. J.		Prof. S. F. Baird	Alcoholic.
13391	1	Montgomery, Ala		T. S. Doran	Do.

AMBLYSTOMA TIGRINUM Green.

(Plate 25, fig. 7.)

Cope, Proc. Ac. Phila., 1867, p. 179; Strauch, Salam., p. 63; Boulenger, Cat. Batr. Grad. Brit. Mus., 1882, ed. II, p. 43.

Salamandra tigrina, Green, Journ. Ac. Phila., V., p. 116.

Salamandra ingens Green, *l. c.*, VI, p. 254.

Salamandra lurida, Sager, Amer. Journ. XXXVI, p. 322, 1839.

Triton tigrinus, Holbr., N. A. Herp., V, p. 79, Pl. 26; De Kay, N. Y. Faun., p. 83, Pl. 15, fi. 32.

Triton ingens, Holbr., *l. c.*, p. 85, Pl. 29.

Ambystoma tigrina, Baird, Journ. Ac. Phila. (2), I, p. 284; Dum. & Bibr., p. 108; Hallow., Journ. Ac. Phila., (2), III, p. 350.

Ambystoma lurida. Baird, *l. c.*, Hallow., *l. c.*, p. 353.

Ambystoma mavortia, Baird, *l. c.*, pp. 284, 292; Hallow., *l. c.*, p. 352.

Ambystoma episcopus, Baird, *l. c.*, pp. 284, 293; Hallow., *l. c.*, p. 354.

Ambystoma proserpine, Baird, *l. c.*, 284, 239; Hallow., *l. c.*, p. 354; U. S. Mex. Bound. Surv., II; Rept., Pl. 35, fig. 7–14.

Heterotriton ingens, Gray, Cat. Batr. Grad., Brit. Mus., ed. I, p. 33.

Xiphonura jeffersoniana, *id.*, *ibid.*, p. 34.

Ambystoma tigrinum, *id.*, *ibid.*, p. 35.

Ambystoma mavortium, *id.*, *ibid.*, p. 37.

Ambystoma californiense, Gray, Proc. Zoöl. Soc., 1853, p. 11, Pl. 7; Hallow., *l. c.*, p. 355; Baird, Rep. U. S. Expl. Surv., XIII, Part IV, Pl. 30, fig. 1–3.

Ambystoma fasciatum, var., Dum. & Bibr., p. 107, Pl. 105, fig. 1.

Ambystoma nebulosum, Hallow., *l. c.*, p. 352.

Ambystoma ingens, Hallow., *l. c.*, p. 353; Cooper, U. S. Expl. Surv., XII. Part II, Pl. 31, fig. 2.

Ambystoma maculatum, Hallow., *l. c.*, p. 355, and Proc. Ac. Phila., 1857, p. 215.

Camarataxis maculata, Cope, Proc. Ac. Phila., 1859, p. 122.

Amblystoma mavortium, Cope, *l. c.*; Strauch, *l. c.*; Cope, in Yarrow's Report, Zoöl., p. 631.

Amblystoma obscurum (Baird), Cope, *l. c.*, p. 192; Strauch, *l. c.*

Amblystoma weismanni, Weidersh., Zeitschr. wiss. Zoöl., XXXII, p. 216, Pl. 11,12.

Larval form.

Siredon lichenoides, Baird, Proceeds. Phila. Acad., 1852, p. 68; Stansbury's Report, 1852, p. 336, Pl. I; Rept. U. S. Pac. R. R., expl. x, Pl. XLIV.

Siredon gracilis, Baird, U. S. Pac. R. R. Rept., x, Williamson's Rept., p. 13, Pl. XLIV, fig. 2.

Desmiostoma maculatum, Sager, Penins. Journ. Medic., 1858, p. 428, fig 1.

Siredon pisciformis, Dumèril, Journal de la Soc. Acclimatation, 1866, figs.

Siredon tigrinus, Velasco, Naturaleza, Mexico, IV, 1878, figs.

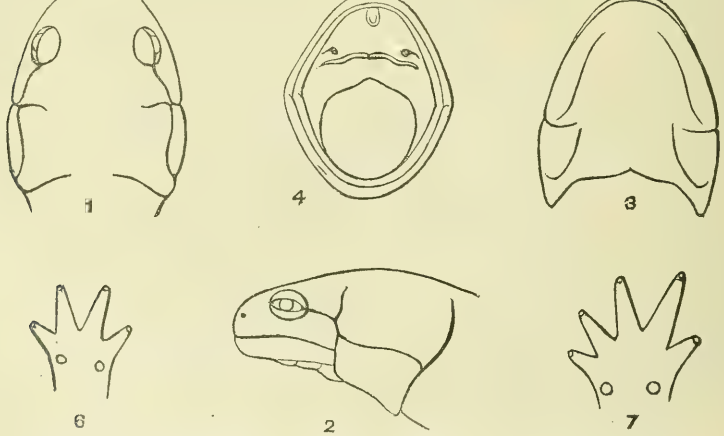

FIG. 12.—*Amblystoma tigrinum*, Green. West Northfield, Ill. No. 4691.

General form very thick and massive, although the head is proportionally small in mature specimens; not as broad as the body. The skin appears quite smooth when fresh, especially when covered with its epidermis. On removing this, however, the skin is seen everywhere closely covered with shallow pits, interspersed with granule-like projections of the glands. There is an indistinct line of pores on each side of the head interior to the eye, but they can be scarcely traced elsewhere.

The parotoid region is much swollen, wider than the skull, and about equal to the distance from snout to gular fold. The width of the jaws is contained about four and one-half times in the distance to the groin, a little more than five to the end of the anus. The gular fold is very distinct, and even overlapping. The grooves behind the jaws and from the eye, obliquely along the side of the head and neck, are also very strongly marked.

The eyes are moderate; not prominent; the pupils circular. They are distant from the nostrils one orbit length and separated anteriorly $2\frac{1}{2}$ orbits; the nostrils are separated one orbit. There is a decided constriction at the neck.

The body is swollen and large, a little depressed; its circumference at the widest is nine-tenths the distance from snout to groin. There are twelve well-marked costal furrows from fore to hind leg, and five pelvic; the fourth and fifth uniting just behind the anus.

The tail is about equal to the distance from snout to groin; it is subquadrate at base; $1\frac{1}{3}$ as high as wide, but becomes immediately oval in section, larger below, and more and more compressed to the tip. The edges are, however, rounded to the terminal third, where they gradually become sharp.

The legs are stout, thickened, and rather short in proportion. The digits are much depressed; short, triangular in shape, tapering from the broad base to the tips, which are hardened and somewhat horny in appearance. The free portion of the longest is about one third the total length of the limb from elbow or knee; sometimes even less. In the individuals which live on land the digits appear longer and more cylindrical. The expanse of the outstretched toes is about four fifths the distance from snout to groin.

The tongue is fleshy, broad, about half the width of the head, and with the outline of the papillose portion slightly emarginate behind.

The palatine teeth of this species extend across the palate very nearly from one side of the upper jaw to the other. The series is only interrupted along the median line; sometimes scarcely so. The line is obtusely angularly rounded anteriorly, the concavity behind reaching forward to about opposite the middle of the internal nares. The slightly convex anterior branches diverge backwards regularly nearly to the line of the inner nares, where the angle of divergence becomes still greater, and the line becomes nearly straight or even concave anteriorly.

There is some variation in the specimens, of the precise outline of the curve of palatine teeth. Sometimes this is less angular anteriorly and does not reach beyond the posterior border of the inner nares.

In life this species is of a dark, livid blackish-brown above, olivaceous on the sides, and from light olive to dirty white beneath. On the upper surface, generally on the side of the tail and limbs, are nearly circular yellow spots about the size of the eye, and generally sharply defined. These are much like those of *A. punctatum*, though not quite so distinct, and although a faint indication of arrangement in ten dorsal rows may be traced, yet these are less symmetrically disposed, and single ones are scattered between the others along the back. Similar scattered spots are seen along the belly, which again is bordered, as on the lower part of the sides, with larger, more quadrate spots, which are more or less confluent, giving rise to elongated blotches, overpowering the ground color. This is also sometimes the case on the belly and almost always on the chin or beneath the head and neck.

The rounded spots above sometimes vary considerably in size, and occasionally are almost wanting. Sometimes they are more or less confluent, in which case there is usually a predominance of yellow on the belly. In a large series of specimens I have not observed any vertical yellow bands on the side of the tail.

In the young, just perfected from the larva, the upper parts are dark brown; the under parts of a uniform brownish-yellow. The yellow spots next make their appearance, becoming more and more prominent to a certain age. In very old specimens the dorsal spots become indistinct, but may generally be discovered when held under water or alcohol.

Dimensions of 4691.

	Inches.
From snout along axial line to end of mouth	
From snout to gular fold	1.00
From snout to groin	3.50
From snout to end of anus	4.40
From snout to end of tail	8.00
Width of head	.80
Fore-arm from elbow	.80
Hind leg from knee	1.10

The longest specimen before me measures 10 inches (4003 Racine). In this the tail from behind anus is as long as the rest of the animal. De Kay describes one of 11 inches in length.

Measurements of a typical specimen of the var. tigrinum (4692).

	Inches.
Length from snout to end of mouth along median line	.45
Length from snout to gular fold	.90
Length from snout to groin	3.10
Length from snout to behind anus	3.75
Length from snout to tip of tail	7.55
Length of tail	3.80

	Inches.
Width of head	.70
Fore-arm from elbow	.75
Hind leg from knee	.95
Greatest height of tail	.65
Stretch of hind legs	2.80

In this variety the appreciable difference in color consists in the tendency to transverse or vertical bars of yellowish on the side of the tail more or less confluent.

I find no difference in form between the two series, the supposed *A. episcopum* now at hand (3899 and 3887) and young specimen of *A. luridum* (as 3971), from Marietta, Ohio. The color above is a light reddish-brown; the sides a sharply defined dusky brown; the belly of a lighter shade of the color of the back. There are some very obsolete indications of whitish spots in the belly and sides.

The following examination of the nature of the variation to which the Eastern form of this species is subject and their causes may be added to the preceding diagnosis from Baird's manuscript.

The color varieties are as follows:

α. Uniform brown above, yellow below, sides darker brown; 3887, 3899; three specimens.

β. Blackish-brown, with small scattered yellow spots above and large ones on the sides, in the majority of the individuals; Nos. 4003, 4097, 4691, 3974, 3895, 3966, 3983, 3970, 3950, 2971, 4692, 4706, and eight in in museum of the Philadelphia Academy.

γ. Nearly equally and not coarsely marbled above, with blotches of deep brown and bright yellow; 4059.

δ. Entirely yellow, with brown linear patches irregularly arranged; type of *A. ingens*, from New Orleans; one specimen.

The above coloration varieties, it will be observed, coincide in part with those of Western individuals.

The conditions of preservation of immature stages in the dentition are as follows:

a. Palatine series nearly entirely transverse behind the internal nares; eight specimens, all from New Jersey except two from Root River, Wisconsin, (4093*a*), and one from Louisiana, 4706. All are fully developed and many of the largest size; one of 4093 has the postnarial dental series separated on one side. Of these the largest example of the species is from Root River. With the other mentioned, the width of the head enters the length to the groin 4.5 times, and the tail is longer than head and body. The same relations are seen in two New Jersey specimens. Two from the latter State have the long tail, but the width of the head is only one-fourth length to groin, while one of the same has the longer body (4.5 times), but the tail shorter than head and body; two specimens have both the short body and tail. The elongation of the tail and body scarcely occurs in connection with any other type of den-

tition, and it is mentioned here to show the greater general completeness of development in these Eastern individuals.

b. Series slightly arched, not passing between nares. Two specimens, large. In No. 3993 both outer segments are well separated from the median; the tail is longer than head and body, and width of jaws 4.33 to line of groin. This individual is aberrant.

c. Series angulated, not extending anterior to anterior margin of inner nares. Nos. 3956, 2971, 3983, 3895, 3899, embracing five specimens, three large ones, in Philadelphia Academy museum, and type of *A. ingens* Green in same.

This latter specimen is peculiar in some respects, as already noted, in coloration. The head is relatively a little wider than in other specimens of the same large size, the width entering the length to the groin four times, as in individuals of the smaller average size of the species. The length of the eye fissure enters 2.5 times the interorbital width, instead of twice, though in one of equal size from Root River it enters 2.2 times. The nares are not more than usually separated; hence the muzzle is more contracted than usual. It is also depressed in profile, but not more than in some other specimens. I believe it not to be a distinct species, but a form dependent on causes similar to those producing others here enumerated, and not more permanent than those, so long as those causes are not universal. In other words, it is a large specimen, with teeth, head, and tail of adult character, but body and muzzle more larval. The fold on the hind leg and outer toe, mentioned by Green, is not marked, or different from that seen in the species generally.

No. 4097, sixteen specimens from western Illinois; two have the series divided into four; 4093, two specimens; No. 4691, Cook County, Ill., thirty-four specimens; one has the three interruptions, and five, with one of 4093, a median, making two series of teeth.

Of the above the tongue is of normal size and the branchiæ absorbed, except in twelve specimens (No. 4691) of which five present stumps of the branchiæ; and two (4097) where both the tongue is very small and the gill-stumps remain. The width of the head is .25 to groin, and the tail never longer than head and body.

d. Median series arched, extending anterior to anterior margin of inner nares. One specimen (3966) is fully developed in all other points.

e. Palatine series angulated, extending anterior to inner nares' anterior border. Nos. 4057, 3974, 3070, two of 4093, 3887, 3899*b*, four of 4097, nine of 4691. All of these have the short head and tail given in the preliminary diagnosis. The small or larval tongue occurs in one of 4093, 3070, 3974, nine of 4691, two of 4097; branchial rudiments remain in two of 4097 and nine of 4691. No. 4057 is remarkable in having a very small tongue, and short deep tail, no stumps of branchiæ, and brilliant coloration, with large size and general adult appearance. It compares with certain specimens (4693, 3984) of the form *mavortium* in this strong retention of some larval characters, and, like them, is from northern Minnesota, a region noted for its cold and late seasons.

Measurements of No. 4057.

	Inches.
Length from snout to end of gape of mouth	.55
Length from snout to gular fold	1.00
Length from snout to groin	3.50
Length from snout to behind anus	4.30
Length from snout to end of tail (about)	8.55
Length of tail (about)	4.25
Depth of tail (at end vent)	1.95
Width of head	1.00
Length of fore-arm from elbow	.90
Length of hind leg from knee	1.10
Stretch of hind leg	3.40

A specimen entirely similar, except in size and coloration, was found by Dr. Horn near Beesley's Point, N. J., a well-known locality for the species. The tail is remarkably thick and deep at the base, and only equal from its basis to the canthus of mouth; a groove in the dorsal line behind; tail not grooved. The color is a dark leaden brown, sprinkled everywhere with small yellow spots; spots larger on tail; belly yellowish. Total length, 6 inches and 5 lines.

From the preceding investigation we gather that larval characters in this species are in part only contemporaneous; that the branchiæ are lost first; the tongue develops next, and the teeth last; that the development extends in older age to the lengthening of the body and tail; that the progress may be arrested at a time when any degree of combination of these and other features exists. That reproduction may take place at any of such different stages is evident from the condition of development of the ova of many of the various specimens, and it is known to take place in other species at earlier stages than any recorded here as adult.

It is also to be noted that specimens from New Jersey are almost always more fully developed than those from the Western regions; the former is a warmer district than the latter. Of two specimens from New Orleans, however, one only exhibits the dentitional characters of the New Jersey individuals. The characters common to the Western individuals have occasioned the opinion that it was another species, which was called *A. mavortium*.

Of this form I remarked in my monograph of the genus Amblystoma, published in 1867, already referred to, that it "differs absolutely only in the broader muzzle and wider separation of the outer nares. The *A. tigrinum* retains in this case a feature characteristic of the larva of *A. mavortium* and of all other Siredon species. The range of color variation is only partly different in the two, but the majority of specimens each belong to different color types. Each occupies a different geographical area, both of which are well marked in the distribution of many other reptiles. Nevertheless, ultimately I think it quite possible that they will have to be viewed as developmental forms, like so many other supposed species which are not sufficiently isolated from one

another at the present time to warrant them distinct places and names in the system." Dr. G. Boulenger, in the last edition of the catalogue of the species of salamanders in the British Museum, 1882, has taken this view of the case, and has reduced the name *mavortium* to the position of a synonym of *tigrinum*. In the present work I take the same view of the relations of the Eastern and Western forms.

The following is a description of a specimen of the Western animal:

Palatine teeth in a transverse series, more or less angular anteriorly, reaching to the posterior border of the inner nares, or one diameter beyond; the angle sometimes flattened or rounded. The series scarcely or not at all interrupted on the median line; never (?) on the limbs, which are generally a little undulating.

Inner nostrils separated by the same space as the outer; rarely a little farther apart.

Tongue broader than long; more than half the width of the head, which is fleshy.

Body heavy, with twelve costal furrows. Head very broad, contained about three and one-half times in distance from snout to groin. Tail about equal to the same distance, much compressed from the base. Males in breeding season with a distinct fin from near the base of the tail above, and from beyond the middle below; tail more oval at other seasons. Cloacal region of male much swollen, emarginate; angular behind.

Legs moderate; digits much depressed, very broad at base, triangular, and adapted for swimming. Free portion of digits about one-third the distance from their tips to elbow or knee.

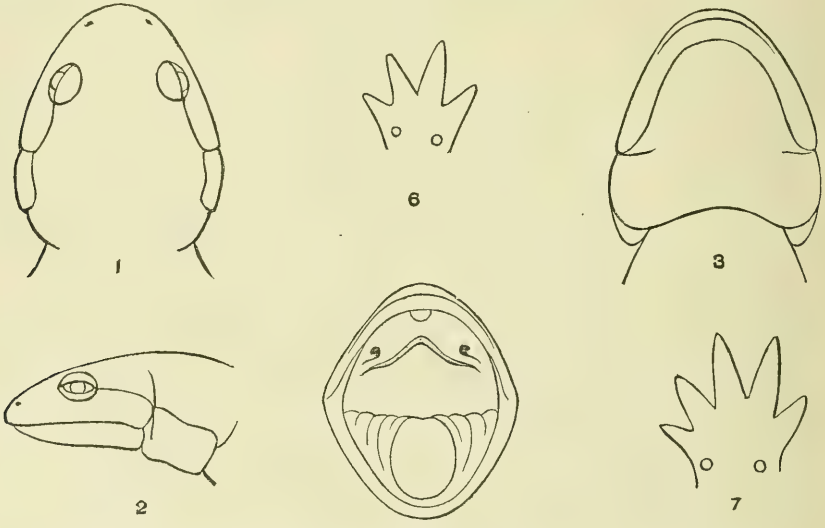

FIG. 13.—*Amblystoma tigrinum* Green, No. 4059. Natural size. Fort Ripley, Minn.

General color dark brown or blackish, in alcohol, varied with blotches of yellow. These are disposed along the median line of the back and

tail, extending down on the sides as transverse ellipsoid bands of large size, perhaps equal to the space between two costal grooves; the blotches of opposite sides sometimes alternate, sometimes are opposite, and are frequently confluent here and there, which is generally the case on the tail, where they form yellow encircling rings, interrupted below. Along the sides of belly and lower part of the sides is a similar series of yellow ellipses, but usually larger; those of the same side usually somewhat confluent, sometimes entirely so, leaving a dusky central line of the belly. The limbs are blotched black and yellow.

The yellow sometimes predominates so as to almost form the ground color, encroaching largely, too, on the yellow of the belly. In general, however, there is little or no tendency to an anastomosis or reticulation of the dark interspaces, as in an allied species. Smaller, rounded, irregularly scattered spots of yellow are seldom, if ever, seen as in Eastern form.

The ground color is sometimes uniformly dusky above, although the lighter transverse ellipses can be usually made out; perhaps they are always appreciable in life.

Duméril and Bibron have given a good colored figure of this form under the name *Ambystome a' bandes*. The green is, however, too brilliant.

In the preceding general description I have endeavored to represent the distinguishing features of what I believe to be a single species varying very much in shape of palatine teeth, proportions, color, etc. From the synonymy it will be seen that I combine under the oldest name of *mavortium*, *proserpine* and *nebulosum* also. Although the type specimens of these supposed species differ sufficiently among each other, yet there are sufficient connecting links in the large series before me, and it would be no difficult task to pick out a dozen more specimens each as distinct from the other and the above as the latter are among themselves.

One great source of the diversity of character in different specimens of this Protean species is to be found in the very different sizes of specimens in the same stage of growth, while in some the full metamorphosis will have been accomplished with a length of three or four inches, in others the branchiæ are still visible at a much greater size. In one female specimen of 8 inches in length (4978), the branchiæ are still appreciable, the fissures in the neck not being closed up, although the ovaries and oviduct would indicate that it was captured when in full breeding condition. This embryonic tendency is almost always indicated further by shorter gape of the mouth, the tongue smaller, flatter, more adherent, not at all or very little free at the edges, and little or not at all papillose, but exhibiting a cartilaginous surface. The palatine teeth in the embryonic state are more arched anteriorly, more or less parallel with the maxillary series, less prominent above the soft palate, and extending a less distance laterally. The digits are more depresed,

their outlines more oval than triangular, the third and fourth toes and second and third fingers more nearly equal. The development of the different embryonic conditions may be carried on very unequally in different specimens, so that one cannot see the true specific characters in small individuals, or even in large ones in which there is the slightest indication of the branchial slits or their tufts.

The same adult individual differs, too, in different seasons. While some species appear to reside almost entirely in water, others do so only partially. Even the same species may pass a more aquatic life in one year than in another. A more persistent residence in water is shown by the broader and more depressed digits, higher and more compressed tail, and more or less decided ridge (sometimes even membranous). I have no doubt that an animal while possessing these features in marked degree when in the water would lose them to a measurable extent after a lengthened residence on land. This aquatic habit is generally greatest during the breeding season.

The preceding paragraph is taken from Professor Baird's manuscript. I will further extend and illustrate the same, and add that the names *A. californiense* and *A. maculatum* have been applied by Gray and Hallowell to forms of this species.

Various changes of form during the late metamorphosis of this animal have been already enumerated in the prefatory remarks on the genus. A feature of difference mentioned above—the varying length of the fourth digit—appears to be quite independent of other developmental conditions. In a specimen in the Museum of the Philadelphia Academy from Kansas, this digit has but three phalanges on both feet; in another locality three on one, four on the other foot, and the same occurs in No. 3994, of the National Museum. In all the other specimens at my disposal they are, as in this section of the genus, 4–4.

The varieties of this species which may be distinguished by their coloration are as follows:

α (Californiense.) Blackish, with slightly paler belly; a series of large, oval, yellow spots on lower part of side and tail (in one specimen a few on each side of dorsal line). System of mucous pores well developed, especially below ramus of the jaw on each side. From California only; eight specimens; No. 4081.

β Brown, yellowish below; larger lateral and smaller dorsal yellow spots, irregularly arranged. Fewer mucous pores on each side the gular region. Fourteen specimens; mostly from Kansas and Nebraska, one from Missouri, one from latitude 38°, two from New Mexico, and two from Chihuahua; Nos. 4065, 4040, 3955*a*, 4062, 4084, 4908, 3984*a*. The type of *A. nebulosum* belongs here. There is no material difference between this and the coloration of *A. tigrinum*.

γ Ground brown, crossed by transverse yellow bands, which inosculate more or less on the dorsal region, so as to obscure, sometimes almost

entirely, the ground; mucous pores, as in the last; belly with a median dark or black band; sometimes the yellow is shaded with olive; Nos. 4613, 4705, 3990, 4703, 4694 to 4699, 3955, 4078, 4079, 4066, 3982, 5359, 4082, 3994. No. 4020 might be assigned to either β or γ.

δ Ground olive, with numerous small brown spots; otherwise as above; No. 4693, and the type of *A. maculatum*.

ε Brown above, yellowish below, otherwise as above; 3984*b*, 4702, 3992, 3955*b*, from most diverse localities.

ζ Color as in γ, the yellow leaving only inosculating lines of brown; no frontal, nasal, or mandibular series of mucous pores; one specimen, No. 4698.

So much as to the principle of ornamental variation. The following are the forms resulting from unequal development of parts. The reader will observe by the numbers how little they coincide with each other and with the preceding.

Type A.—Palatine teeth in a gentle arch, convex forwards, not extending between nares; the teeth (but not the ridge) interrupted inside the series behind the nares. Nos. 4908 and 5359 (2 specimens); in all respects fully grown, the former not more than half the size of the usual type. Approach distantly *A. trisruptum* Cope.

Type B.—Palatine teeth forming a straight series on each side, meeting at a more or less open angle between the nares. Most of the specimens; Nos. 4702, 3992, 4705, 4613, 4065, 4040, 4698, 3990, 4703, 4694, to 4699, 4081, 3955, 4079. Of these, the angle of the tooth series does not extend beyond the anterior margin of the nares in twenty-six specimens, of which one exhibits a small, undeveloped tongue, and none have the stumps of the branchiæ remaining. In eleven specimens the angle extends beyond this point (in 3990, and another approaching an arch in form), and of these the tongue is small and larval in six, and in one of these stumps of the branchiæ remain; this last is of medium size only, but Nos. 4693 and 3694 are large, the first very large; they add the larval character of a short, deep tail. It is to be noted that these specimens are from Minnesota and the borders of British America—regions subject to great cold—to which cause we may with much probability assign their characters. Two individuals presenting the same peculiarities are described under the head of *A. tigrinum*.

Of two specimens from Chihuahua, fully developed, the teeth are of the two types; of eight from California, one presents the second type only; it is otherwise fully developed.

Type C.—The postnarial portion of the palatine series has nearly or quite assumed its transverse position, while the median series remains in its larval arch, extending more or less in advance of the nares. Eight specimens, four of the largest size; 3955*a*, 4078, 4062, 4084; two Museum of Philadelphia Academy, one type of *A. maculatum* Hall. Of these, two have the small tongue and traces of branchiæ, while four are fully developed in these respects.

Type D.—Palatine series forming a parabolic arch from one extremity to the other, extending in advance of the nares. Three specimens, two of them of full but not large size; one of the former fully double the size of others from the same locality (the Platte Valley), which are referred to types C and B, with larval tongue and branchial stumps. The others (4066), with larval tongue, but the branchiæ absorbed.

Here may be mentioned a remarkable specimen (3982), which is in all other respects fully developed, where the larval arch of teeth remains, but has become open and slightly transverse, extending but little beyond the anterior margin of the nares. It is intermediate between types D and A, and is the result of a retardation in development of the larval arch, while type B is produced by a retardation by the preservation of the oblique lateral series of the larva at the expense of the arch.

I add here a description of the var. obscurum (*Amblystoma obscurum* Baird, Proceeds. Acad. Phila., 1869, p. 192).

The head is very broad and the gape unusually large. The internal nostrils are very large, their width half the diameter of the eye; the distance between their inner borders is the same as that between the outer. The tongue is large, broader than long, its width about two-thirds that of the upper jaw.

The palatine teeth are in four series, collectively forming a broad inverted V; the angles anterior, and would be quite sharp but that there is an interruption along the median line. The branches reach as far forward as the anterior border of the inner nostrils. They are decidedly concave antero-externally. The ten inner anterior sections of the palatine series are each about twice the length of the external ones; they fall short of the inner border of the inner nares by nearly a diameter of the latter, which space separates them from the outer section, which, immediately behind the inner nares, are about as long as the latter are wide, and do not pass exterior to their outer border.

There are twelve costal furrows. The tail is compressed, but not high.

The color appears to have been of a uniform brown above and on the sides, brownish yellow beneath. On the sides darker vertical blotches can be detected in the single specimen before me. Similarly indistinct markings are visible on the tail.

The very convex frontal region and the concave interrupted series of teeth alone distinguish this variety from the *A. tigrinum* of the West.

It differs from *A. tigrinum* of the East in much larger inner nares and more widely separated nostrils, the inner borders of the two being at about the same distance, instead of having the latter more approximated. The tongue is wider, as well as the head. The teeth are more V-shaped and reach farther forward. The outline of the limbs of the V is concave antero-externally and is interrupted by spaces equal to the wide nostrils, the outer section not extending beyond the nostrils.

The specimen which represents this variety is from Fort Des Moines, Iowa (No. 3994.)

The characters of the variety californiense (*Amblystoma californiense* Gray) are as follows:

The proportions and general character of the glands, pits, etc., appear much like those of *A. tigrinum;* in some respects of *A. punctatum.* I do not detect any patches of large pores on the top of the head and neck in one specimen, but in another a series of large whitish dots beneath the epidermis seems to indicate their presence. Of these one patch is placed on top of the head, within the orbit; another on the parotid region. Some pores, however, are distinctly visible behind the angle of the mouth, sending forward a series along the margin of the lower jaw under the chin.

The head is broad, but also long, the width being decidedly less than the distance from snout to gular fold. The gape is very large, the length nearly two-thirds the width. The width in seven specimens is contained 4½ times in the distance from snout to groin; in one specimen 4 times only. The eyes are separated only by 2½ lengths of the orbit.

The tongue is very large, nearly filling the whole lower jaw. It is three-fourths the width of the head.

There is quite a difference in the character of the palatine teeth of the ten specimens before me. In both the central part of the series forms a decided V, the angle sharp, and reaching to the anterior margin of the inner nostrils. The limbs extend backwards, slightly in an S shape, a short distance behind the inner nostrils and in line with their inner border, and then connect with the external segments of the palatine series, which extend (nearly transversely, but a little obliquely backwards) to a line with the outer margin of the inner nostrils. In both specimens the two sides of the palatine series are not symmetrical and of unequal length. One specimen shows a distinct interval between the central V and the lateral segment, as well as at the angle of the V; in the other the four elements are continuous.

There appear to be twelve costal furrows. The tail is compressed, but not high; in one specimen it is as long as head and body; in another shorter. Shows a sharp ridge above from near the base and for the terminal half below in one specimen; not so much in another.

The limbs are well developed, the digits depressed and triangular, but less so than in many aquatic *Amblystomata.*

The color of the species is blackish in alcohol; rather paler below. On each side of the belly or lower part of the sides of body and tail is a series of bright sulphur-yellow spots, mostly nearly circular, sometimes oblong, and varying in size, though generally larger than the orbit. The spots are few in number; five or six from head to tail and four or five on the side of tail.

In one of the specimens are some smaller rounded spots on each side of the dorsal line, three or four in each series. These are not symmetrically disposed, as in *A. punctatum.*

As Dr. Gray remarks, this variety has a certain resemblance exter-

nally to *A. punctatum*, which, however, never exhibits the series of spots on the side of belly and lower part of sides of body and tail, the spots being confined to the vicinity of the median line above. In *A. t. californiense* when dorsal spots occur they are less regular, though of much the same size. In typical *A. tigrinum* the yellow spots are much smaller, more numerous, and more scattered; very prominent on the belly. There are many essential differences in form from *A. punctatum*—as the more widely separated external nostrils, the anterior angle of the palatines, the depressed short digits, more compressed and sharply ridged tail, etc.

A description of a specimen of var. *γ* may also be useful for reference.

The form is very heavy and clumsy; the head very broad; the gape twice as wide as long. The inner nares are about as far apart as the outer. The gular fold is very distinct and overlapping; the neck much constricted. There is no dorsal groove distinctly evident.

The tail is much compressed and elevated. In the type selected there is a sharp ridge above and below near the tip.

The limbs are rather short; the digits very broad at the base, triangular, and much depressed. There is little appreciable difference in the length of the third and fourth toes.

The tongue is very broad, wider than long, filling the rami anteriorly and considerably more than half the width of the head.

The palatine teeth form a nearly continuous series; nearly straight, but slightly obtuse anteriorly where it reaches to the line of the posterior border of the inner nares. Laterally the series extends one diameter of the inner nares beyond their outer margin. The limbs of the very obtuse V are not straight, but slightly bow-shaped. There is a slight interruption along the median line.

The ground color is purplish black, with transversely elongated blotches of yellow. These appear to be arranged in one dorsal series on each side the median line of the back (coming up to it and the opposite ones sometimes confluent), and another on the side of the belly, of larger size and ascending high on the sides. The latter are sometimes more or less confluent on the same side. The central region of the belly is generally of the dark ground color. There may be six or eight of these blotches from head to base of tail, and as many on the side of the tail, where, indeed, they generally form yellow rings, interrupted below. The limbs are blotched black and yellow in about equal proportions.

Proportional dimensions.

(Spec.—39551. *Ambystoma tigrinum*, Fort Bliss, N. Mex.)

Head:

Length of gape of mouth to its width	one-half.
Width of gape of mouth to distance from snout to gular fold	equal.
Width of gape of mouth to distance from snout to groin	contained 3½ times.
Width of gape of mouth to distance from snout to behind anus	4½ times.

Head—Continued.
From snout to gular fold contained in distance from snout to groin ... 3½ times.
From snout to gular fold contained in distance from snout to behind anus ... 4½ times
Distance anteriorly between eyes in length of orbit ... 3 times.
Distance from eyes to nostrils in length of orbit ... 1+ time.
Distance between external nostrils in length of orbit ... nearly 2 times.
Distance between internal nostrils in length of orbit ... 2¼ times.
Width of tongue to width of head ... rather more than ½ time.
Limbs:
Free portion of longest finger contained in distance from elbow to tip ... 3 times.
Free portion of longest toe contained in distance from knee to tip ... nearly 4 times.
Distance between outstretched toes in length from snout to groin ... once.
Tail: Length from behind anus to rest of animal ... nearly equal.
Body: Number of costal furrows (including axillary and inguinal) ... 12

Measurements, in inches.

Length, measured along axis of body:		Head—Continued:	
From snout to gape	.60	Distance between inner nostrils	.45
From snout to gular fold	1.00	Tail:	
From snout to groin	3.50	Height of tail where highest	.75
From snout to behind anus	4.50	Breadth of tail where highest	.45
From snout to end of tail	4.00	Limbs:	
Head:		Free portion of longest finger	.30
Width of head	1.05	From elbow to tip of longest finger	.95
Width of tongue	.55	Free portion of longest toe	.32
Length of tongue	.45	From knee to tip of longest toe	1.15
Length of orbit	.22	Distance between outstretched toes	3.50
Distance between eyes anteriorly	.65		
Distance between outer nostrils	.40		

Proportional dimensions.

(Spec. 4696. Cimarron River.)

Head:
Length of gape of mouth to its width ... about one-half.
Width to distance from snout to gular fold ... equal.
Width to distance from snout to groin ... 4 times.
From snout to gular fold, contained in distance from snout to groin ... 4 times.
From snout to gular fold, contained in distance from snout to behind anus ... nearly 5 times.
Distance anteriorly between eyes in length of orbit ... 3 times.
Distance from eyes to nostrils in length of orbit ... 1⅓ times.
Distance between external nostrils in length of orbit ... nearly 2 times.
Distance between internal nostrils in length of orbit ... 2 times.
Width of tongue to width of head ... little over ½ time.
Limbs:
Free portion of longest finger contained in distance from elbow to tip 3¼ times.
Free portion of longest toe contained in distance from knee to tip ... 3½ times.
Distance between outstretched toes in length from snout to groin ... about equal.
Body:
Width compared with that of head ... equal
Number of costal furrows (including axillary and inguinal) ... 12

Measurement, in inches.

Length, measured along axis of body:	
From snout to gape	.55
From snout to gular fold	1.00
From snout to armpit	1.55
From snout to groin	3.90
From snout to behind anus	4.75
From snout to end of tail	8.75
Head:	
Width of head	1.00
Length of orbit	.20
Distance between eyes anteriorly	.56
Distance between outer nostrils	.35
Distance between inner nostrils	.36
Body:	
Circumference of belly	3.75
Body—Continued:	
Distance between armpit and groin	2.25
Tail:	
Height of tail where highest	.70
Breadth of tail where highest	.40
Limbs:	
Free portion of longest finger	.27
From elbow to tip of longest finger	.95
Free portion of longest toe	.32
From knee to tip of longest toe	1.25
Distance between outstretched toes	3.55

Proportional dimensions.

(Spec. 4082. Type of *A. proserpine*, Tamaulipas).

Head:	
Length of gape of mouth to its width	more than half.
Width of gape of mouth to distance from snout to gular fold	not quite equal.
Width of gape of mouth to distance from snout to groin	nearly 4 times.
Width of gape of mouth to distance from snout to behind anus	4½ times.
From snout to gular fold contained in distance from snout to groin	3½ times.
From snout to gular fold contained in distance from snout to behind anus	4 times.
Distance anteriorly between eyes in length of orbit	3 times.
Distance from eyes to nostrils in length of orbit	1 time.
Distance between external nostrils in length of orbit	nearly 2 times.
Distance between internal nostrils in length of orbit	nearly 2 times.
Width of tongue to width of head	more than half.
Limbs:	
Free portion of longest finger contained in distance from elbow to tip	3 times.
Free portion of longest toe contained in distance from knee to tip	3 times.
Tail: Length from behind anus to rest of animal	less.
Body: Number of costal furrows (including axillary and inguinal)	12

Measurements, in inches.

Length, measured along axis of body:	
From snout to gape	.34
From snout to gular fold	.60
From snout to armpit	.90
From snout to groin	2.00
From snout to behind anus	2.40
From snout to end of tail	4.10
Head:	
Width of head	.52
Distance between eyes anteriorly	.32
Distance between outer nostrils	.23
Distance between inner nostrils	.24
Tail:	
Height of tail where highest	.25
Breadth of tail where highest	.12
Limbs:	
Free portion of longest finger	.20
From elbow to tip of longest finger	.60
Free portion of longest toe	.19
From knee to tip of longest toe	.61
Distance between outstretched toes	1.75

Proportional dimensions.

(Spec. 4081. *Ambystoma trigrinum californiense*, Petaluma, soft sp.)

Head:

- Width to distance from snout to gular fold ..... $1\frac{1}{4}$ times.
- Width to distance from snout to groin ..... $4\frac{1}{2}$ times.
- From snout to gular fold contained in distance from snout to groin .... $3\frac{2}{3}$ times.
- From snout to gular fold contained in distance from snout to behind anus ..... $4\frac{1}{2}$ times.
- Distance anteriorly between eyes in length of orbit ..... $2\frac{1}{2}$ times.
- Distance from eyes to nostrils in length of orbit ..... $1\frac{1}{3}$ times.
- Distance between external nostrils in length of orbit ..... $1\frac{2}{3}$ times.
- Distance between internal nostrils in length of orbit ..... not 2 times.

Width of tongue to width of head ..... two-thirds.

Limbs:

- Free portion of longest finger contained in distance from elbow to tip ..... not quite 3 times.
- Free portion of longest toe contained in distance from knee to tip ..... 3 times.

Tail: Length from behind anus to rest of animal ..... less.

Measurements, in inches.

Length, measured along axis of body:		Body: Distance between armpit and groin	1.75
From snout to gape	.40	Tail:	
From snout to gular fold	.85	Height of tail where highest	.30
From snout to armpit	1.25	Breadth of tail where highest	.18
From snout to groin	3.00	Limbs:	
From snout to behind anus	3.75	Free portion of longest finger	.28
From snout to end of tail	6.20	From elbow to tip of longest finger	.80
Head:		Free portion of longest toe	.30
Width of head	.70	From knee to tip of longest toe	.90
Width of tongue	.45	Distance between outstretched toes	2.85
Length of orbit	.18		
Distance between eyes anteriorly	.40		
Distance between outer nostrils	.30		
Distance between inner nostrils	.30		

Habits, etc.—The larvæ of this species are exceedingly abundant in all still water in the Rocky Mountain Region and the Plains. They are rapacious, eating animal food, and taking the hook readily. Late in the summer they complete their metamorphosis and take to the land, where they hide in the holes of marmots, badgers, etc. From these they emerge during and after rains. The larvæ are much less frequently seen in the East, where the species is less abundant, and the opportunities of concealment are greater. Market Lake is a temporary body of water covering many square miles in eastern Idaho. It is formed by the overflow of the Snake River in spring. On its shores I have found this species. On the shore of an adjacent pond of more permanent character I have observed this species occupying vertical holes, which were kept filled with water by occasional waves, but from which their heads emerged into the air. In this position their branchiæ were gradually absorbed. An adult from New Jersey occupied a burrow in the soil of my fernery for several weeks. The burrow had two orifices, in one or the other of which its head could be generally seen, observing what was going on,

Professor Baird first reached the conclusion that the early stage of this species is a Siredon, and he suspected on that account that the *Siredon mexicanus* of the valley of Mexico is the larva of an unknown species of Amblystoma. Long afterwards Prof. Auguste Duméril received some larvæ of the *A. tigrinum* from Mexico and observed their metamorphoses in the reptile-house of the Jardin des Plantes of Paris. He supposed the species to be the *Siredon mexicanum*, but I showed that it was the *Amblystoma tigrinum* ("*mavortium*"), after an examination of specimens sent by him to me to Philadelphia.* Since then Professor Marsh at New Haven, and Madame Chauvin in Switzerland, have observed the metamorphosis of the same species. Professor Duméril also showed that it can reproduce while still branchiferous.

Siredon mexicanum Wagl. (*Amblystoma mexicanum* Cope) inhabits Lakes Chalco and Xochimilco, in the valley of Mexico. Its metamorphosis has never been observed, but it is asserted by I. M. Velasco to take place. It is readily distinguished from the larva of the *Amblystoma tigrinum* by its color. It is of a pinkish gray, and is covered with numerous small round, dusky spots, rather closely placed. While nearly related to the larva of the *A. tigrinum*, it is clearly a different form. Should it prove to be the case that it does not undergo a metamorphosis, the genus Siredon, of which it is the type, must be retained. A second species, the *S. dumérili*, has been described by Dugés from Lake Patzcuaor in the State of Guanajuato. Its color is uniform.

Amblystoma tigrinum Green.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3979	1	Detroit, Mich		A. Sager	Alcoholic type.
9273	1	Virginia	Sept. —, 1874		Alcoholic.
10889	1	Webster City, Iowa	May 21, 1878	Chas. Aldrich	Do.
4097	8	Northern Illinois		R. Kennicott	Do.
4691	10	West Northfield, Ill		do	Do.
9188	2	Chicago, Ill	Sept. 7, 1877	Sweeny	Do.
10082	1	Edgefield, S. C	Apr. —, 1879	S. H. Loud	Do.
9929	1	Webster City, Iowa		Chas. Aldrich	Do.
4059	1	Fort Ripley, Minn		Dr. J. F. Head, U. S. A	Do.
3956	1	New York			Do.
4908	1	Independence, Mo		Dr. J. G. Cooper	Do.
3993	1	Russellville, Ky		Dr. Thos. H. Webb	Do.
3966	2	Mississippi		Dr. B. F. Shumard	Do.
4097	3	Northern Illinois		R. Kennicott	Do.
3895	1	Saint Louis, Mo			Do.
4040	2	Lake Encinito, Chihuahua.		J. Potts	Do.
4691	6	West Northfield, Ill		R. Kennicott	Do.
4003	6	Racine, Wis		Prof. S. F. Baird	Do.
3974	5	Columbus, Ohio		Prof. L. Lesquereux	Do.
3990	1	New Mexico		Dr. J. L. Le Conte	Alcoholic type.
9185	6	Fort Union, N. Mex		Peter Connell	Alcoholic.
8456	1	Nutrias, N. Mex		Dr. C. G. Newberry	Do.
8294	5	Bonito Cañon, Ariz		General W. E. M. Arny	Do.
8455	1	Arizona	—— —, 1874	J. M. Rutter	Do.
7839	1	Fort Reynolds		A. Clough	Do.
9186	1			Lieut. W. L. Carpenter, U. S. A.	Do.
3955	1	Fort Bliss, N. Mex		Dr. S. W. Crawford, U. S. A.	Do.
4079	1	Fort Benton, Mo		Dr. F. V. Hayden	Do.
4082	3	Tamaulipas, Mex		Dr. L. A. Edwards, U. S. A.	Do.

* Proceedings Philadelphia Academy, 1858.

Amblystoma tigrinum Green—Continued.

RESERVE SERIES—Continued.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4694	1	Mouth of Cimarron		J. H. Clark	Alcoholic.
4695	1	Fort Riley, Kans		Dr. W. A. Hammond, U.S.A.	Do.
4697	1	Lower Platte		Dr. J. H. Cooper	Do.
10775	1	Fort Laramie, Wyo		Chas. Ruby	Do.
10776	1	do		do	Do.
10777	1	do		do	Do.
10888	1	Sydney, Nebr	Feb. 10, 1876	Lieut. S. W. Crawford, U. S. A.	Do.
10217	5	Mexico			Do.
10900	7	Dakota		C. A. K.	Do.
10901	5	Peterson, Utah	Dec. 5, 1878	F. Hirst	Do.
3984	2	Lac-qui-parle, Minn		S. R. Riggs	Do.
4702	1	Fort Tejon, Cal		Dr. S. W. Woodhouse	Do.
5457	1	Fort Bridger, Wyo			Do.
5359	1	Nebraska		Lieutenant Reynolds and Dr. F. V. Hayden.	Do.
4061	2	Santa Fé Creek		R. H. Kearn	Do.
4066	2	Rock Creek		Lieut. F. T. Bryan, U. S. A.	Do.
10217	5	Mexico		Mus. Nat., Mexico	Do.
4693	1	North Red River			Do.
12603	6	Utah Lake	— —, 1882	Jordan & Gilbert	Do.
4068	1	New Mexico		John Potts	Alcoholic type.
8457	3	South Park, Colo	June —, 1873	Dr. J. T. Rothrock	Alcoholic.
9187	3	Santa Fé, N. Mex			Do.
12542	2	Fort Steele, Wyo		Chas. Ruby	Do.
11928	4	Northern Boundary Survey.	— —, 1874	Dr. E. Coues	Do.
12013	1	Fort Randall, Dak		U. S. A. Hospital	Do.
3994	1	Des Moines, Iowa		(?)	Do.
8675	1	Arizona	— —, 1875	Lieutenant Bergland	Do.
4078	1	Fort Thorn		Captain Pope	Do.
12541	1	Fort Steele, Wyo		Chas. Ruby	Do.
13394	1	Ottawa, Canada	— —, 1883	Dr. Robert Bell	Do.
4065	1	Rio Mimbres, N. Mex		Dr. Webb	Do.
3167		San Elezario, Tex		Major Emory	Do.
9186	3	Santa Fé, N. Mex		(?)	Do.
3992	2	Southern Illinois		R. Kennicott	Do.
11888	1	Camp Supply, Ind. T.		Dr. T. E. Wilcox, U. S. A.	Do.
13623	1	Archer, Fla		Dr. Chas. C. Neal	Do.
11427	1	Yellowstone Lake		Lieutenant Hayden	Do.
14488	1	Auburn, Me	— —, 1883	G. P. Merrill	Do.
14490	4	Fort Wingate, N. Mex.	— —, 1885	Dr. R. W. Shufeldt, U. S. A	Do.
4706	2	Grand Coteau, La		Saint Charles College	Do.
3887	1	Ann Arbor, Mich		Prof. S. F. Baird	Do.

GENERAL SERIES.

5119	2	Kansas			Alcoholic.
11838	1	Old Fort Cobb, Tex		Dr. E. Palmer	Do.
4060	7	Bridger's Pass, Wyo		Lieut. F. T. Bryan, U. S. A.	Do.
4613	1	Cheyenne Pass		Dr. E. Swift, U. S. A.	Do.
4020	1	Fort Laramie, Wyo		Lieut. S. Warren, U. S. A	Do.
11720	5	Platte Valley, Nev		C. Drexler	Do.
3955	4	Fort Bliss, N. Mex		Dr. S. W. Crawford, U. S. A.	Do.
10895	5	(?)		E. Ingersoll	Do.
10890	1	Kansas		Dr. E. Palmer	Do.
10894	1	(?)			Do.
3899	2	Detroit, Mich		A. Sager	Do.
9416	1	Waukegan, Ill		J. W. Milner	Do.
11925	1	Northern Boundary Survey.	— —, 1874	Dr. E. Coues	Do.
11549	2	(?)		(?)	Do.
4057	1	New Mexico		(?)	Do.
11710	1	(?)		S. F. Baird	Do.
4084	1	Santa Fé, N. Mex		(?)	Do.
3983	1	Rock Island, Ill		J. B. Sargent	Do.
14112	1	Indiana	— —, 1885	O. P. Hay	Do.
14426	1	Southern Kansas	do	Chas. Ruby	Do.
14427	1	do	do	do	Do.
3971	1	Marietta, Ohio		Professor Andrew	Do.
14449	1	(?)		(?)	Do.
14462	2	(?)		(?)	Do.
14481	1	New Mexico		A. S. McClellan	Alcoholic type.
14483	1	(?)		(?)	Alcoholic.
14486	1	(?)		(?)	Do.
14487	1	(?)		Dr. F. V. Hayden	Do.

Amblystoma tigrinum californiense Gray.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4081	2	Petaluma, Cal		E. Samuels	Alcoholic.
11794	1	Fresno, Cal	— —, 1879	Gustav Fisen	Do.
14073	1	El Paso, Tex	— —, 1884	Newton Simmons	Do.

AMBLYSTOMA TRISRUPTUM Cope.

Proceeds. Acad., Phila., 1867, p. 194.

The species is stout and heavy in build; the head very broad and much depressed. The skin is granulated by contraction of the alcohol, but in respect to glands, pits, etc., appears much like other species. There is, however, a decided feature in certain particles which crowd the parotoid region, and are seen also on the top of the head along the inner margin of the orbit, and perhaps below the eye. I have not noticed this character in any other species east of the Rocky Mountains.

The head is broad, ovate, rather pointed anteriorly. The inner and outer nostrils are nearly the same distance apart. The tongue is broader than long, more than half the width of the head, filling the interspace of the same anteriorly.

The teeth are in four very distinct patches, with decided intervals. They form one transverse series, nearly straight centrally (where they are in a line with the posterior border of the internal nares), but curving slightly backwards laterally. The two central patches are wider than the lateral, which vary a little in length and are separated by an interval half the diameter of the inner nares. Their distance from the exterior patches is about twice as great, the center of the interval falling about opposite to the inner border of inner nares. The outer patches extend about half a diameter beyond the outer border of inner nares.

The remaining external characters of the specimen are not different from those of *A. tigrinum*.

The colors of the specimen are much obscured by bad preservation. It appears to have been of a uniform dark blackish or bluish brown, with a single series of large transversely elliptical blotches of yellow from head to tip of tail, half on body and half on tail; the foremost one rounded and placed behind the eyes. Those of opposite sides nearly meet on the back, and are confluent on the upper edge of the tail.

This is the only species I have seen of the group in which a strictly transverse series of palatine teeth behind the eye is divided into four groups.

The only known specimen is the following:

No. 4068; 1 specimen; Ocate Creek, New Mexico. ♀.

Ocate Creek is on the eastern side of the Sangre de Cristo Mountains, the southern part of the eastern range of the Rocky Mountains in New Mexico.

Proportional dimensions.

(Spec. 4068. Ocate River, New Mexico. ♀.)

Head:
- Length of gape of mouth to its width ..... little more than half.
- Width to distance from snout to gular fold ..... not quite equal.
- Width to distance from snout to groin ..... 4 times.
- From snout to gular fold contained in distance from snout to groin .... 2½ times.
- Distance anteriorly between eyes in length of orbit ..... 3 times.
- Distance from eyes to nostrils in length of orbit ..... 1¼ times.
- Distance between external nostrils in length of orbit ..... not quite 2 times.
- Distance between internal nostrils in length of orbit ..... 2 times.
- Width of tongue to width of head ..... over one-half.

Limbs:
- Free portion of longest finger contained in distance from elbow to tip ..... little over 3 times.
- Free portion of longest toe contained in distance from knee to tip ..... 3½ times.
- Distance between outstretched toes in length from snout to groin .. about equal.

Tail: Length from behind anus to rest of animal ..... less.

Body: Number of costal furrows (including axillary and inguinal) ..... 12 (?).

Measurements, in inches.

Length, measured along axis of body:	
From snout to gape	.45
From snout to gular fold	.90
From snout to armpit	1.45
From snout to groin	3.15
From snout to behind anus	3.80
From snout to end of tail	6.80
Head:	
Width of head	.80
Width of tongue	.45
Length of orbit	.18
Distance between eyes anteriorly	.50
Distance between outer nostrils	.22
Distance between inner nostrils	.30
Body: Distance between armpit and groin	1.80
Tail:	
Height of tail where highest	.46
Breadth of tail where highest	.24
Limbs:	
Free portion of longest finger	.26
From elbow to tip of longest finger	.90
Free portion of longest toe	.29
From knee to tip of longest toe	.96
Distance between outstretched toes	3.00

AMBLYSTOMA XIPHIAS Cope.

Proceeds. Acad. Phila., 1867, p. 192; Strauch, Salam., p. 64; Boulenger, Catal. Batr. Grad., Brit. Mus., ed. II, 1882, p. 45.

The specimen selected as the type of the description has the skin somewhat altered by alcohol, so that an exact description can not be made of the glands, pits, and pores. There does not, however, appear to be any material difference from *A. tigrinum* in these respects.

The head appears small in proportion to the size of the animal, and the cheeks unusually swollen; the width of the head is contained about four and one-half times in the distance to groin. The eyes are rather small, distant three lengths of the orbit; the inner nostrils are considerably more distant than the outer. The tongue is large and fleshy, filling

the rami anteriorly, and more than half the width of the head. The inner nostrils are quite lateral.

The palatine teeth form a very obtuse angle anteriorly, reaching to about opposite the middle of the inner nares and extending laterally beyond them by about one diameter. There is a slight interruption along the median line, but no appreciable one elsewhere. The limbs of the V are not entirely straight, but form a double curve (scarcely appreciable) on each side. There are twelve costal grooves. The pelvic grooves are not appreciable, and only those at the base of the tail.

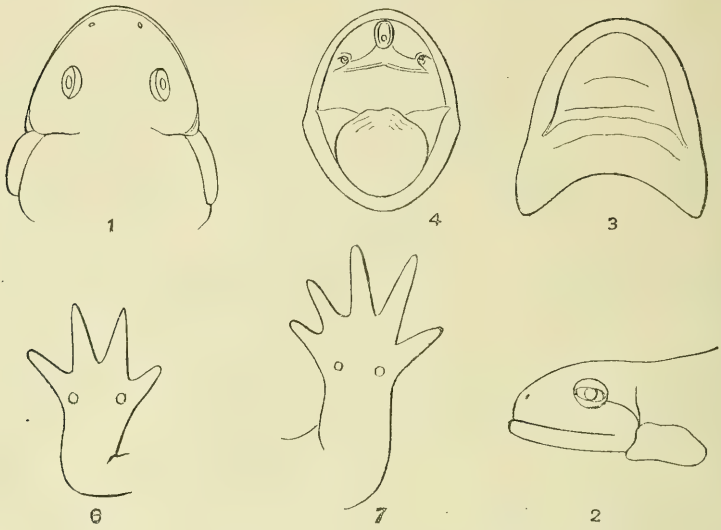

FIG. 14.—*Amblystoma xiphias*. No. 4135. Columbus, Ohio.

The tail is very long, considerably exceeding the rest of the animal, much compressed from the base, though not elevated; oval in cross-section, and only becoming sharp near the tip, without any crest. No grooves are visible along dorsal or ventral outline.

There do not appear to be any peculiarities in the feet distinguishing it from other aquatic Amblystomas.

The color of this species is a yellowish-olive; brighter yellow beneath, with more or less anastomosing or reticulating bands of well-defined brown on the back and sides, and a few rounded spots of the same on the belly. These bands in width average, perhaps, the diameter of the eye, though variable in this respect. Compared with *A. tigrinum*, this species has a proportionally smaller head, more prominent lower jaw, much longer tail, and different color; yellow predominating in the one and brown in the other. The relationship, however, appears to be very close. The digits, perhaps, are narrower, though also triangular and depressed.

The only specimen of the *A. xiphias* yet known is from Columbus, Ohio (No. 4135).

AMBLYSTOMA JEFFERSONIANUM Green.

(Plate 25, fig. 9.)

Cope, Proceeds. Acad. Phila., 1867, p. 195; Strauch, Salam., p. 64; Boulenger, Cat Batr., Grad. Brit. Mus., ed. II, 1882, p. 46, Pl. II, fig. 2.

Salamandra jeffersoniana, Green, Contr. Maclurean Lyceum, p. 4; Holbr., N. A. Herp., v, p. 51, Pl. 14.

Xiphonura jeffersoniana, Tschudi, Batr., p. 93; Dum. & Bibr., p. 161.

Triton niger, De Kay, N. Y. Faun., III., p. 85, Pl. 15, fig. 35.

Salamandra granulata, De Kay, N. Y., *l. c.*, p. 78, Pl. 23, fig. 66; Holbr., N. A. Herp. v, p. 63.

Amblystoma jeffersoniana, Baird, Journ. Ac. Phila. (2), I, p. 283.

Amblystoma fuscum, Hallow., Journ. Ac. Phila. (2), III, p. 355, 1865.

Amblystoma jeffersonianum, var. *fuscum*, Cope, Proc. Ac. Phila., 1867, p. 197; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 46.

Costal grooves twelve; mucous pores on each side of the muzzle not extending beyond the orbits. Teeth transverse, or nearly so, in three series. No or one indistinct plantar tubercle. External and internal nares equidistant; lead colored to brown and black, with or without pale or distinct lateral spots.

This definition covers a considerable range of variation, which is expressed in the following diagnoses of three subspecies:

Width of head 4 to 4.5 times in length to groin; length of eye 2.5 times in width of head above; uniform lead color to brown ..... *A. j. jeffersonianum.*

With of head 5 times in length to groin; length of eye one-half width of head between anterior canthus of eyes; black with white spots on sides and belly. *A. j. laterale.*

Width of head 5 times to groin; length of eye 1.75 in width of head as above; tooth series slightly convex; slender; uniform lead color ..... *A. j. platineum.*

Amblystoma jeffersonianum jeffersonianum Green.

The synonymy given under the head of this species in general is applicable to this subspecies only.

Body decidedly more slender and elongated than in *A. punctatum.* Skin everywhere smooth, and showing through the transparent epidermis the ends of the glands which thickly stud the entire surface. Under a lens are seen numerous small, rounded, shallow pits between the glands, not on them. The contraction of the skin in strong alcohol between these glands would readily impart a granulated appearance. The glandules are accumulated into a thin stratum above the parotoid groove.

The head is elongated, with the muzzle obtuse or truncate, the greatest width contained 1.5 times in the distance to the gular fold, and from four and a half to five times to the groin; the distance to the gular fold is contained $3\frac{2}{3}$ times in that to the groin. The eyes are rather large and situated far behind. They are distant once the length of the orbit from the nostrils (which are separated by nearly twice this length). The anterior extremities of the orbit are distant more than twice their length.

The gular fold or furrow is distinct, not very prominent above; that behind the angle of the jaws is inconspicuous, as is the lateral parotoid furrow.

There are twelve costal furrows, including the inguinal and axillary.

The tail is a little shorter than the body and head (measuring from posterior extremity of vent). It is oval in cross-section, widest below, though without any ridge or crest. It is little higher than broad at the anus, but becomes more and more compressed to the tip, the upper and under outlines remaining nearly parallel for a considerable distance. The anal slit is prolonged into a groove, which extends beneath the tail to its very tip.

The limbs are largely developed and the toes very long. The digits are cylindrical, depressed, without any lateral or basal web. The third finger is longest, then the second, fourth, and first. It is one-third the length of arm from elbow. The fourth toe is longest; then the third (but little shorter), second, fifth, and first; it is contained about two and one-half times in the length of leg from knee. The expanse of the outstretched toes is very nearly equal to the distance from snout to the groin. The length of the limbs varies a little; when extended on the sides they may scarcely meet or considerably overlap.

The tongue is thick and fleshy, much as in *A. punctatum*.

The teeth are in four patches; the two central in a nearly straight line, or forming in smaller individuals a very obtuse $\wedge$, the angle anterior but not passing the posterior border of the internal nares. The sides of the V are perhaps slightly concave anteriorly. This patch or line extends to the inner nares, and is there continuous with the lateral patches, which are short, nearly straight, about one-fourth the central patch, and form the posterior border of the inner nares. These are large, far back, and widely separated.

In alcohol, after long immersion, the specimen is nearly uniform light liver-brown, paler beneath, without any spots.

Measurements.

	Inches.
Length from snout to gular fold	.70
Length from snout to groin	2.55
Length from snout to end of anus	3.20
Length from snout to remnant of tail	2.50
Width of head	.50
Length of mouth along median line	.38
Fore-arm from elbow	.62
Leg from knee	.85

The specimen from which the preceding description has been taken is, if not the original upon which Dr. Green's species was founded, at least one collected in the same locality and named by him, having formed part of his collection and presented many years ago by its owner to the Smithsonian Institution. The "light-blue spots" so conspicuous in fresh specimens have disappeared.

Dr. Holbrook, in describing this species, has mixed with it the account of the tongue and teeth of *Plethodon glutinosus*, which it somewhat resembles, but which may readily be distinguished externally by the lighter silvery spots and much shorter digits. This induced Dr. Hallowell erroneously to make the species a synonym of *P. glutinosus*. The error had its origin, no doubt, in the nearer resemblance of the var. *A. j. laterale* to the latter species.

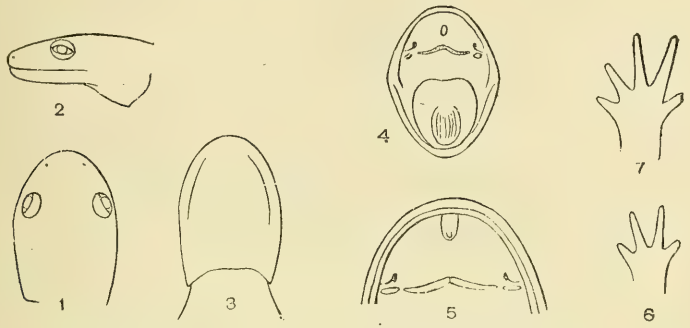

FIG. 15. *Amblystoma jeffersonianum jeffersonianum*. No. 3968. $\frac{1}{1}$ except f. 5=$\frac{2}{1}$; W. Pennsylvania.

A comparison of the specimen described with the type of De Kay's *Salamandra granulata* exhibits no appreciable difference except in the darker color, rather more depressed toes, and perhaps more massive-looking jaws of the latter, the muzzle a little more pointed—all uncertain characters in alcoholic specimens. The palatine teeth are in better preservation than in the specimen here described. The central patch is interrupted along the median line, and does not extend quite so far laterally. The legs and digits are much lengthened, the figure and description of Holbrook (see De Kay) conveying a very erroneous impression in this respect. The granulation referred to is in part the optical effect of the glands of the skin showing through the transparent epidermis, partly the result of contraction of the skin by alcohol.

In the type specimen there are no symmetrically arranged patches of pores on the head. Their absence may be owing to the long-continued preservation of the specimens, or to some accidental deficiency. In the type of *S. granulata* these are quite visible. They are very distinctly shown in No. 4688, where there is seen a straight series interior to the eye and nostril (not reaching to the latter), bending abruptly behind the eye and passing beneath it. On the parotoid region above the lateral groove is a slightly curved line of six or eight pores and a shorter straight one above it. Below the groove is a crowded patch, which is continued in a simple series along the inner edge of the lower jaw. One or two are seen at the side of the base of the lower jaw, and others along the sides of body.

It has been stated that in the type no indication of light spots was visible. In others, however, of more recent preservation these are

quite evident. In the smallest specimen of 3998 are visible numerous rounded, irregularly disposed light spots on the lower part of the sides, with some scattered over on the belly, averaging half the size of the eye, but with faintly defined margins. Some scattered ones are seen on the side of the tail. These may be plumbeous or bluish in life. In the largest specimen of 3979, Ripley, Ohio, these bluish spots are quite evident on the side of body and tail.

Generally the ground color of the alcoholic specimen is lead-colored to olive brown and blackish; light beneath. The color of the living animal is similar to that seen in alcoholic specimens. Specimens have been found at localities rather distant from each other of a dark brown color, with a lateral shade of a still darker hue. Such specimens are of the stouter type of the species as to proportions. Of two specimens from Clark County, Va., the width of the head enters the length to the groin $4\frac{1}{2}$ times in one specimen, and the other but little over four times. Other specimens are from Saint Catherine's, Ontario, in the National Museum, and from southern Indiana in the Philadelphia Academy. They have been referred to as distinct species and described as *Amblystoma fuscum* by Hallowell, but I cannot find any characters to distinguish them from the *A. jeffersonianum* proper. They resemble almost exactly the *A. copeanum* in color, but differ entirely in proportions. In that species the body is not longer than the length anterior to the axilla, while in this one the former dimension much exceeds the latter.

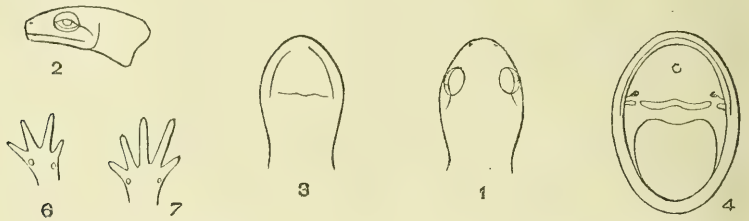

FIG. 16. *Amblystoma jeffersonianum*, type of var. *fuscum*. No. 3897. Clarke County, Va.

A specimen of *A. jeffersonianum* about 2 inches long is not materially different from the adult, although the two inner palatine patches are more arched.

Amblystoma jeffersonianum laterale Hallow.

Amblystoma laterale, Hallow., *l. c.*, p. 352.

Amblystoma jeffersonianum, var. *laterale* Cope *l. c.*, Boulenger; Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 47.

This form is quite distinct from the typical *A. jeffersonianum*, and would rank as a species were it not that its character and those of the latter interblend. In typical specimens of the *A. j. laterale* the head is narrower and the body more slender. When the limbs are laid along the sides they frequently do not meet by a short interval, while those

of the *A. j. jeffersonianum* touch each other and even overlap a little. The median portion of the dental series usually exhibits a slight angulation anteriorly, while that of the typical subspecies is straight; but this character is in some cases not retained. The color is generally easily recognized: black with light lateral spots. It resembles in this respect the *Plethodon glutinosus*, and to a less degree the *Amblystoma microstomum* as pointed out by Hallowell, and the unwary observer may easily confound it with one or the other of these species. But lateral spots appear in some specimens of the typical variety, and the ground color varies, as has been already described.

This form is altogether northern in its distribution, being especially abundant in Canada.

Amblystoma jeffersonianum platineum Cope.

Check-list, p. 26; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 47.

Amblystoma platineum, Cope, *l. c.*, p. 198; Strauch, Salam., p. 65.

This is a very elongate form of the *A. jeffersonianum*.

The head is oval and the muzzle rounded. The length of the fissure of the eye equals the distance of the nostril from the same; is but little less than the distance between nares, and half or a little more of the distance between the anterior canthus of the same. Inner and outer nares the same distance apart. Greatest width of head 5.5 to six times in length from end muzzle to groin, five-sevenths length from chin to gular fold. Canthus of mouth behind canthus of eye. A series of pores along the superciliary, which pass round the orbit behind and below; a scattered longitudinal series on the parotoid region, and a transverse aggregation of the same on each side below parotoid groove; a single series of the same for a short distance inside the ramus of the mandible. The parotoid region possesses a thin stratum of dermal cryptæ.

Costal folds twelve. The anterior is a little distance behind the axilla. Toes subcylindric, similar to those of the *A. jeffersonianum*; in one specimen (type) they are separated by nearly an intercostal space when the limbs are pressed to the sides; in another they meet. Tail rounded above at base, finally much compressed, but not elevated; equal in one specimen to body and head to middle of orbit, measured from posterior extremity of vent. In the type, however, it is much shorter, extending from its basis only to the eighth costal fold (from groin), but I suspect that this is abnormal.

Color leaden; in type paler below, with numerous indistinct whitish blotches. Eyelids yellowish margined. Specimen 4688 has the abdomen darker and without spots.

The narrower head and more elongate body will distinguish this species from the typical *A. jeffersonianum*. It is readily distinguishable

among many individuals. Nevertheless many of those of the subspecies *A. j. laterale* approach it in the proportions of the parts of the head to each other, including the closer approximation of the eyes and of the nostrils. The body is, however, always shorter. The size of the *A. j. laterale* is considerably less. Those of the typical variety of the same subspecies are invariably stouter, not only in body, but especially in the head.

Amblystoma jeffersonianum jeffersonianum Green.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3968	1	Western Pennsylvania		Dr. J. Green	Alcoholic type.
3979	4	Ripley, Ohio		Dr. P. R. Hoy	Alcoholic.
3997	1	Racine, Wis		do	Do.
4690	1	St. Catherine's, Canada.		Dr. D. W. Beadle	Do.
4884	1	Mount Joy, Pa		J. Stauffer	Do.
3888	2	Burlington, Vt		L. Thompson	Do.
10830	1	Lucknow, Ontario	July 15, 1881	Dr. J. H. Garnier	Do.
3877	1	Ohio		Dr. J. S. Newberry	Do.
3981	2	New York			Do.
3998	2	Cleveland, Ohio		Dr. J. P. Kirtland	Do.
13625	1	West Virginia		John W. M. Appleton	Do.

Amblystoma jeffersonianum fuscum Hallow.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4022	2	St. Catherine's, Canada.		Dr. D. W. Beadle	Alcoholic.
3897	2	Clarke County, Va		(?)	Do.
14471	2	St. Catherine's, Canada.		Dr. D. W. Beadle	Do.

Amblystoma jeffersonianum platineum Cope.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
7145	1	Cleveland, Ohio		Professor J. P. Kirtland	
4688	1	Unknown		Professor Agassiz	
5368	1	Moose River, British America.		C. Drexler	Alcoholic.

Amblystoma jeffersonianum laterale Hallow.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
5941	3	Near Lake Abitib, Hudson's Bay.		C. Drexler	Alcoholic.

AMBLYSTOMA MACRODACTYLUM Baird.

(Plate 25, fig. 6.)

Baird, Journ. Ac. Phila. (2) I, p. 292, and U. S. Expl. Expedition, XII, part 2, Pl. 31, fig. 3; Cope, Proc. Ac. Phila., 1867, p. 198; Strauch, Salam., p. 65; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 48.

This species is the slenderest of all our species of *Amblystoma;* in this respect, as well as length of digits, exceeding the typical *A. jeffersonianum*, but resembling the *A. j. platineum.*

The head is rather large, depressed, and elongated, with a moderate constriction at the neck. The eyes are prominent, and distant less than two lengths of the orbit. The outer and inner nostrils are each about one orbit distant. The width of the head is about three-quarters the distance to gular fold.

The tongue is oval and longitudinal. The palatine teeth are in three or four patches, the central largest, occasionally separated by an interval less than half the diameter of the inner nostrils. Together they form a line slightly angular anteriorly where they reach to about opposite the center of the inner nostrils; laterally they pass a little the outer margin of the inner nostrils.

The body is cylindrical, depressed, with twelve costal furrows. The tail is long and is compressed for its distal half. The digits are longer than in any other species of the genus, the interior being well developed on both extremities. On the fore-foot it equals the external toe in length, while on the hind limb it is a little shorter than the fifth. The phalanges are: In front, 2, 2, 3, 2; behind, 2, 2, 3, 4, 2.

The color in alcohol is leaden brown, with a well-defined broad dorsal stripe of grayish-brown, which, involving the whole upper surface of the head and neck, contracts on the nape, swelling again on the back, with an average breadth of the outer orbital space. This stripe extends to the end of the tail. On each side of this dorsal stripe is a suffusion of dark brown, which gradually pales through the color of the sides onto the belly. There are also a few spots of the same in the dorsal stripe. There are a few grayish-white dots scattered along the sides, and perhaps on the limbs.

Two specimens (4054) from Puget Sound agree in form with the preceding specimen, the two central patches of palatine teeth perhaps a little more angularly arranged. Instead of the grayish dorsal stripe, however, there is a brownish-red one, and the sides are of a darker and more continuous brown. No. 4711 has a similar character of palatines, but a coloration more like the type. The palatines, in fact, extend a little in front of the anterior border of the inner nostrils.

Proportional dimensions.

Spec. No. 4042, (type).

Head:

Length of gape of mouth to its width	two-thirds.
Width to distance from snout to gular fold	about three-quarters.
Width to distance from snout to groin	5 times.

Head—Continued.

From snout to gular fold contained in distance from snout to groin.... 3½ times
Distance anteriorly between eyes in length of orbit ..... less than 2 times.
Distance between external nostrils in length of orbit ..... one orbit.
Distance between internal nostrils in length of orbit ..... one orbit

Limbs:

Free portion of longest finger contained in distance from elbow to tip ..... about 2⅔ times.
Free portion of longest toe contained in distance from knee to tip..... 2½ times.
Distance between outstretched toes in length from snout to groin.. about equal.
Body: Number of costal furrows (including axillary and inguinal) 12

Measurements, in inches.

Length, measured along axis of body:		Body: Distance between armpit and groin	.90
From snout to gape	.20	Tail: Height of tail where highest	.18
From snout to gular fold	.44	Limbs:	
From snout to armpit	.65	Free portion of longest finger	.15
From snout to groin	1.50	From elbow to tip of longest finger	.39
From snout to behind anus	1.82	Free portion of longest toe	.20
From snout to end of tail	broken.	From knee to tip of longest toe	.50
Head:		Distance between outstretched toes	1.50
Width of head	.30	Total length of a larger specimen	4 in. 4 lin.
Width of tongue	.17		
Length of orbit	.12		
Distance between eyes anteriorly	.20		
Distance between outer nostrils	.12		
Distance between inner nostrils.	.12		

This species is found in suitable localities throughout Oregon and Washington, ranging as far east as Fort Walla Walla, and even as far as Fort Custer, near the Big Horn River, Wyoming, from which a specimen was brought by Capt. Chas. Bendire.

Numerous specimens from Fort Walla Walla and six from Fort

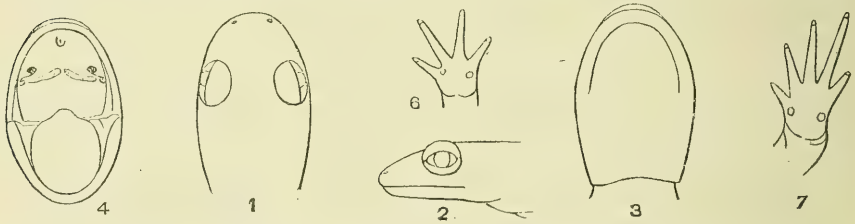

FIG. 17. *Amblystoma macrodactylum.* No. 4042. Astoria, Oregon. ⅔

Klamath differ from those from more western regions in the absence of the dorsal color stripe. In some of the former the width of the head enters the length to the groin 5½ times, showing a narrower form than in the typical form. In others of them the head has the usual width. The single specimen from Fort Custer has the dorsal band. A salamander from the Flathead River, Montana, was described by Professor Peters under the name of *Amblystoma kraussii.** There is nothing in the description to show that this specimen does not belong

* Sitzungsberichte der Gesellschaft Naturforschende Freunde, Berlin, 1882, p. 145.

to the *A. macrodactylum*. The width of the head, says Peters, enters the length to the groin $4\frac{2}{3}$ times. The dorsal band is ochraceous, while in typical *A. macrodactylum* it is glaucous or mauve color.

Amblystoma macrodactylum Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4054	2	Puget Sound, Oregon		Dr. Geo. Suckley, U. S. A.	Alcoholic.
4012	1	Astoria, Oregon		A.N. S., Phila	Do.
5982	6	Chilowyuck Lake, Oreg.		Dr. C. B. R. Kennerly	Do.
6878	3				Do.
8863	2	Fort Klamath, Oregon	Oct. 2, 1876	Willis Wittich	Do.
12591	2	Garrison Creek, Wash		Capt. Chas. Bendire	Do.
11468	1	Fort Walla Walla, Wash.	June —, 1881	do	Do.
5248	1	do		Lieutenant Mullen	Do.
12587	2	Oregon	— —, 1881	Capt. Chas. Bendire	Do.
10922	4	Fort Walla Walla, Wash.	— —, 1881	do	Do.
11591	6	do	— —, 1881	do	Do.
14466	2	do	— —, 1881	do	Do.
—	6	Fort Klamath, Oregon		H. McElderry, M. D	Do.
14524	1	Fort Custer, Mont		Capt. Chas. Bendire	Do.
4711	1	Semiahmoo, Wash		A. Campbell	Do.
4035	2	Washington Territory		Dr. J. G. Cooper	Alcoholic larva.

AMBLYSTOMA EPIXANTHUM Cope.*

Proceed. Acad. Philad., 1883, p. 16.

Nearly related to *Amblystoma macrodactylum* Baird, and to be placed next to that species in any synopsis of the genus. Costal folds twelve. No canthus rostralis. Upper jaw overlapping lower. Tail strongly compressed, as long as head and body to groin. Head wide-oval; its greatest width one-fourth in total length to the groin. Digits all rather short; four phalanges in fourth posterior digit. Internal nares as widely separated as the external. Eye-fissure one-half width between the anterior canthus. Median dental series presenting an angle forwards. Tongue large, deeply plicate. Length, m. .083; length to axilla, .017; to groin, .040; length of anterior limb, .012; of anterior foot, .004; of hind limb, .014; of posterior foot, .0065.

Sides of body and tail and superior surfaces of limbs, shining black. Dorsal region to end of tail and muzzle, gamboge-yellow. The yellow expands on the head and forms two cross-bands on the upper surfaces of each of the limbs. The black of the sides is occasionally interrupted by the yellow spots irregularly placed. Below, dilute black, dusted with minute white speckles.

The structural differences between this and the *A. macrodactylum* are not many, but are well marked. They are: (1) The greater width of the head, which enters the length (without the tail) five times in the latter, and four times in the *A. epixanthum*; and is also seen in the greater interorbital width; (2) in the short toes, which are very much longer in the *A. macrodactylum*. In color this species is the more bril-

*Plate 25, fig. 8.

liant; the coast species being described as brown with a gray dorsal stripe, instead of black with a yellow dorsal stripe. In it the limbs are not banded, and the belly is uniformly pale, contrary to what holds in the present species, which is the handsomest of the genus. I obtained four specimens of this salamander, under logs, in a swamp near the head of the South Boise River, on the south side of the Sawtooth Mountain range, Idaho.

FIG. 18. *Amblystoma epixanthum*, Atlanta, Idaho; ½.

This species is in all respects more robust than the *A. macrodactylum*, and is more brilliantly colored. Its tints are those of the European *Salamandra maculosa*, and are brighter than those of any other species of the genus. Its hyoid apparatus is represented on Plate 23, fig. 8.

CHONDROTUS Cope.

American Naturalist, 1887, p. 88 (January).

Otoglossal cartilage triangular, attached by a base to each side of the hypobranchial cartilage.

In other respects this genus agrees with Amblystoma. The larva of the type species (*C. tenebrosus*), the only one I have identified, differs from those of *Amblystoma* in the absence of basal branchial processes, and of splenial teeth. (Plates 20–21.)

I have examined the hyoid apparatus of five species of this genus, and I refer two others to it. One of these, *C. cingulatus*, very probably belongs here; the position of the other, *C. texanus*, is altogether uncertain as yet.

Considered with respect to the forms of their otoglossal cartilages these species fall into three sections, as follows (see Plates 25 and 26):

(1) The cartilage uninterrupted in front. *C. tenebrosus*, *C. aterrimus*, and *C. decorticatus*. (Figs. 1, 4–5, 8–9.)

(2) The cartilage divided in front, and without median processes. *C. paroticus*. (Figs. 6–7.)

(3) The cartilage divided, each half with an internal and external process in front. (Figs. 1–2, Pl. 26.) *C. microstomus*.

In addition to these characters, it may be observed that in the *C. tenebrosus* and *C. aterrimus* there is a sheet of strong fibrous tissue extending anteriorly from the otoglossal cartilage, and forming the base of the tongue. A few similar fibers are found in the corresponding position in the *A. paroticum*.

Besides the characters of the otoglossal cartilage I have already given, I may add that in the species with entire anterior border, the crest of the superior surface of the basibranchial appears to pass through a

foramen in the base of the otoglossal cartilage. Where the latter is fissured the crest appears to be decurved through it, as in *C. paroticus*, Pl. 25, Fig. 6.

The species of this genus are distributed as follows:

AUSTRORIPARIAN REGION.—*C. microstomus* and *C. cingulatus*.

PACIFIC REGION.—*C. paroticus*, *C. decorticatus*, *C. aterrimus*, and *C. tenebrosus*.

The *C. microstomus* is not common in the eastern part of the Austrioriparian region, but is chiefly found in the Mississippi Valley and Texas. The Pacific species are all northern, none being yet known from the middle and southern parts of California.

The species of *Chondrotus* are characterized as follows:

I. Vomeropalatine tooth series extending exterior to the line of the internal nares; lingual plicæ radiating from behind; parotoids not distinct.

α. Canthus rostralis distinct; tail shorter than head and body.

Muzzle elongate, flat, produced beyond nostrils; vomeropalatine teeth in two rather short series, which present an open angle backwards; brown, marbled with darker brown spots ..... *C. tenebrosus.*

II. Series of teeth extending to external fissure of inner nares; lingual plicæ radiating from behind; parotoid glands forming a distinct ovoid mass.

α. Teeth in three series (no canthus rostralis or plantar tubercles); fourth toe with three phalanges.

Muzzle not produced; median series of teeth forming an open angle forwards; width of head 4.5 to groin; legs stout; toes long; tail longer than body; uniform brown ..... *C. paroticus.*

III. Series of teeth not extending beyond inner line of nares; lingual plicæ radiating from behind; no distinct parotoid mass (species large).

α. Twelve costal folds; no plantar tubercles; fourth toe with three phalanges.

Vomerine teeth in one transverse series behind posterior line of choanæ; tail nearly as long as head and body; muzzle very obtuse; nostrils terminal; light brown, with reticulations of dark brown ..... *C. decorticatus.*

Vomerine teeth in two sigmoids, which converge and join anterior to choanæ; tail only as long as body; muzzle flat, produced beyond nostrils; uniform black ..... *C. aterrimus.*

αα. Fourteen costal folds; fourth toe with four phalanges.

Teeth arched between inner nares; head one-fourth to groin (in small specimens); eye one-half width between canthus; muzzle broad; outer nearer together than inner nares; brown, with a series of lighter spots on upper part of sides, below yellowish; muzzle and tail marbled with the same. *C. texanus.*

IV. Series of teeth not extending beyond inner margin of nares; lingual plicæ radiating from a median longitudinal furrow of the tongue; no distinct parotoid mass (species small).

α. Two series of teeth; no canthus rostralis (fourth toe with four phalanges).

β. Tail compressed, equal to the body.

Mandible shorter than muzzle; head elongate, width between eyes behind equal from same to nares; width of head 6.5 times in length to groin; limbs longer, separated when appressed, by two intercostal spaces; black, with numerous narrow gray annuli on body and tail ..... *C. cingulatus.*

Mandible longer than muzzle; head short, broad; width between eyes behind equal from same to end muzzle; body stouter; width of head 6.5 to 7 times in length to groin; limbs short, separated by six costal spaces; lead-colored, with a few gray shades below ..... *C. microstomus.*

CHONDROTUS CINGULATUS Cope.*

Amblystoma cingulatum Cope, Proc. Ac. Phila., 1867, p. 205; Stranch, Salam., p. 65; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 50.

This species approaches the *C. microstomus* in general, but may be readily known by its more elongate-ovoid head, with long muzzle, more slender form of body, and peculiar coloration.

Mucous crypts and pores are not much developed in this animal; a few only of the latter extend along the superciliary region. The costal folds are fourteen, and are visible across the abdomen.

The head is elongate, convex both transversely and longitudinally; the upper face of the muzzle is narrowed, and projects beyond the mandible. The width at the jaws enters the length to the groin $6\frac{1}{2}$ times, and $1\frac{3}{4}$ to the edge of the gular fold. The external nares are quite close together, nearer than the long diameter of the eye, and nearly 1.5 this diameter in advance of the eye. The anterior angles of the latter are 2.33 diameters apart. The folds on the side of the head and neck are as in other species. The distance between the inner nares is 1.66 times the distance between the external.

The tongue is oval, quite elongate, but not filling the space between the rami of the mandible; its median groove strongly marked. The palatine teeth are in a single row, slightly convex forwards, entirely between the inner nares, their posterior margins of the ends of the series and nares corresponding. The gape of the mouth is short, but longer than in *C. microstomus*; its external canthus falls anterior to the posterior canthus of the eye, while the anterior canthus of the same measures the posterior third of the gape, commencing at the middle of the premaxillary region.

Costal grooves fourteen; a median dorsal groove strongly marked. An unusually strong fold across between angles of mandible, which sends a branch to the orbit; gular fold continued on neck, sending a parotoid groove forwards. Length to gular fold 3.75 in length to groin.

Length of tail nearly equal from basis of same to the mental cross-fold. It is of rather uniform depth, much compressed, keeled above and for its distal half below. General form of the body slender and compressed, elevated at the scapular and pelvic regions.

Limbs stout; the fingers slender, but not very elongate. Appressed to the sides they fail of meeting by the length of the sole and longest toe; length from tip to tip when outstretched, .66 length to groin. Length of lower leg and foot, scarcely .8 from muzzle to gular fold. No visible plantar tubercles. Fourth toe distinctly longer than third; then 2, 4, 1. Fingers 3, 2, 4, 1.

Color in alcohol black, the under surfaces thickly speckled with gray. A vertical narrow gray line passes between every pair of costal folds and meets its fellow on the dorsal line or bifurcates to meet a similar bifurcation in like manner, embracing areæ. These narrow annuli ex-

* Text, fig. 117.

tend nearly as far forwards as the orbits, and surround the tail to its extremity. Muzzle black.

Measurements.	In.	Lin.
Total length	3	6.
Length to canthus oris (straight)		2.25
Length to gular fold		6.
Length to groin		18.7
Width of head		3.2
Width above femora		2.25

The shades of coloration in this creature are those of the *Amblystoma opacum*, but are differently arranged.

No. 3786; 1 spec.; Grahamville, S. C.; —— Bailey.

CHONDROTUS MICROSTOMUS Cope.*

American Naturalist, 1887, p. 88.

Amblystoma porphyriticum, Hallow., Proc. Ac. Phila., 1856, p. 8 (*nec Salamandra porphyritica*, Green).

Amblystoma microstomum Cope Proc. Ac. Phila., 1867, p. 206; Strauch, Salam., p. 65; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 50, Pl. II, fig. 4.

This species is among the most slender of American Amblystomidæ, and has other peculiarities by which it is readily recognizable. The skin is very smooth and slippery, with the glands less evident in the skin than in *A. opacum*, *jeffersonianum*, etc. The skin is everywhere covered with small shallow pits, only visible when the mucus is removed, which shows the tail to be sometimes conspicuously granulated, the granules probably corresponding to the ends of the glands. There are no evipores or pits of larger size than the others on the head and parotid, as dent in some Amblystomata.

The head is very small, narrower than the body, with little or no constriction at the neck. It is contained about six and one-half to seven times in the distance to the groin. The muzzle is short and wide. The head is much arched in every direction, the eyes far forward and lateral. The lower jaw projects a little beyond the border of the upper, concealing the latter when viewed from above. The eyes are distant less than the length of the orbit from the nostrils, their anterior extremities separated by 1½ times this unit. The nostrils are one orbit length apart. The anterior edge of the orbit falls opposite the middle of the gape instead of in its posterior third, as in *Amblystoma jeffersonianum*. The gular fold is distant from the snout one-fifth the distance to the groin.

The body is slender for the genus. There are fourteen costal furrows, including the inguinal and axillary. There is a slight indication of a dorsal groove posteriorly.

The tail is about two-thirds the head and body. It is nearly cylindrical at base, and then becomes slightly compressed, more and more so to the tip, where it is quite flat, but without crest, although the edges are sharp. Viewed from the sides, there is a constriction at the base of the tail. It is one-fourth higher in the middle than at the base.

*Plate 25, figs. 1, 2.

The limbs are weak. The digits are however very long, cylindrical, depressed, without membrane. The proportions of the digits are as in *A. punctatum*. The longest finger is but one-third the fore-arm; the longest toe is a little more than one-third the leg from knee. The outstretched hind legs are about two-thirds the head and body to groin. When the fore and hind legs are extended and appressed to the sides they are separated by six of the intercostal spaces. This indicates that the legs are shorter than in any other species of the genus. The tongue is thick, fleshy, and attached, although slightly free at sides and tip. There is a longitudinal groove in the tongue, separating the two papillose portions, of an oval shape, placed side by side, with the edge of the tongue projecting beyond them. The papillæ form parallel series in each oval oblique to the central groove. This is not found in *Amblystoma jeffersonianum*.

There are only two patches or lines of palatine teeth. These occupy the middle of the palate, forming an $\wedge$, the angle anterior and reaching as far forward as the anterior border of the inner nares. The postero-external ends do not pass the inner margin of those nares (in the soft palate, the proportions being a little different in the skull).

Sometimes these two patches form nearly a straight line, or at least the central portion is straight, the lateral bending slightly backwards.

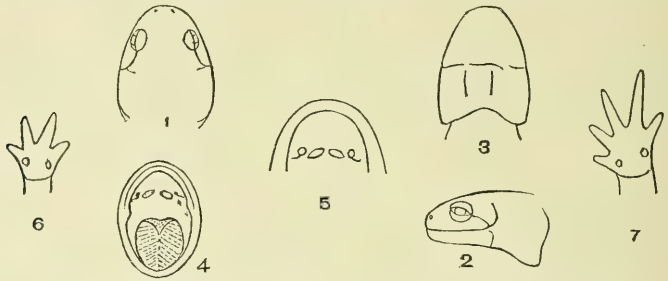

FIG. 19. *Chondrotus microstomus*. No. 3999. Saint Louis, Mo.; ½.

The color in alcohol is a dark brownish-black, a very little paler beneath, and thickly and irregularly sprinkled on the sides with plumbeous spots about the size of the eye, of no definite outline. These are less numerous above and below, sometimes nearly wanting; sometimes they are larger than as described, and look not unlike patches of a grayish lichen growing on the sides.

Measurements.

	Inches.
Length along axis of body from snout to angle of mouth	.20
Length from snout to gular fold	.45
Length from snout to groin	2.20
Length from snout to behind anus	2.50
Length from snout to tip of tail	4.00
Length of tail	1.50
Width of head	.31
Length of fore-arm from elbow	.40
Length of leg from knee	.46
Expanse of hind legs	1.45

The total length of largest specimen seen (3999, Saint Louis) is 6 inches, of which the tail forms 2.60. The smallest adult is 2 inches long.

In the just perfected young is seen a series of illy-defined light spots, larger than elsewhere along each side of the back. The belly is quite light colored.

This species bears a close resemblance to *Plethodon glutinosus*, from which the generic peculiarities, the longer digits, etc., readily distinguish it. The bluish spots, too, are much less sharply defined and duller, less silvery, and do not occur on the back to anything like the same extent as in *P. glutinosus*. From *A. jeffersonianum* it will be known by the projecting lower jaw, much smaller and more arched head, greater number of costal furrows, more evident spots on the sides, etc., besides the important peculiarities of tongue and teeth.

This is one of the species whose metamorphosis is completed sometime before it attains full size. A specimen in which minute stumps of the branchiæ remain measures 2 inches in length; another without traces of them, 2.15 inches. The width of the head enters the length to the groin 4.2 times, and the tail falls short of the axilla from its base. These measurements may be compared with those of the adult in illustration of the general principle that the relative lengths of body and tail increase with increased size.

The well-developed lateral processes of the otoglossal cartilage approach the character of Amblystoma more than is seen in any other species of Chondrotus. Its very long median processes are not found in any other species of this genus. Although they lie closely appressed in the long axis of the tongue, they are homologous, each with a half of the circle of Amblystoma.

Chondrotus microstomus Cope.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8875	1	Mandeville, La	Nov. —, 1876	N. O. Academy	Alcoholic.
8837	1	Mount Carmel, Ill	June —, 1875	Samuel Turner	Do.
3999	1	Saint Louis, Mo.		Dr. Geo. Englemann	Do.
5982	1	(?)			Do.
3884	5	Prairie Mer Rouge, La.		Jas. Fairie	Do.
3902	4	New Madrid, Mo		R. Kennicott	Do.
4037	1	Fort Smith, Ark		Dr. B. F. Shumard	Do.
11056	3	Mount Carmel, Ill	Nov. —, 1881	L. M. Turner	Do.
11878	9	Wheatland, Ind.	Apr. —, 1881	Robert Ridgway	Do.
3995	1	Columbus, Ohio		Prof. L. Lesquereux	Two larvæ.
3949	6	New Madrid, Mo		R. Kennicott	Pulli.
11050	3	Mount Carmel, Ill	Nov. —, 1881	L. M. Turner	Alcoholic.
8906	1	Oakley, S. C.	Apr. 5, 1887	F. W. Hayward	Do.
12058	3	Mount Carmel, Ill		L. M. Turner	Do.
8777	2	Belleville, Ill		Dr. A. Reuss	Do.
13846	1	Hudson's Bay	—— —, 1884	F. W. Hayden	Do.
11564	1	(?)		(?)	Do.
14472	1	(?)		W. U. Tel. Ex	Do.
14474	1	Saint Louis, Mo.		Dr. Geo. Engelmann	Do.
4096	30	Southern Illinois		R. Kennicott	Do.
4001	2	Lancaster, Ohio		L. Lesquereux	Do.
4687	2	Grand Coteau, La		St. Charles College	Do.

CHONDROTUS TEXANUS Matthes.

(Plate 51, fig. 19)

Salamandra texana, Matthes, Allgem. deutsche naturh. Zeitung, I, 1855, p. 266.
Amblystoma texanum Baird, U. S. Mex. Bound. Surv., II, Rept., 29, Pl. 35, fig. 15; Cope, Proc. Ac. Phila., 1867, p. 204; Strauch, Salam., p. 65; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 50.

The description of this species is taken from specimens which are not fully grown. The proportions are, however, much those of the *C. microstomus* at the same age. This, with the large number of costal grooves, renders it almost certain that the full-grown individuals are much like those of the latter species, and very probably of near the same size.

Skin everywhere quite smooth; no traces of pores on the head or parotoid region in many specimens. Costal folds fourteen, distinct; head folds slightly marked, the gular slight. A median dorsal groove.

Head oval, rather flattened and broad; canthus rostralis somewhat marked. Mouth large; canthus behind eye, anterior canthus of latter marking middle of margin. Nostril a little nearer eye-fissure than length of latter, probably equal in older specimens. Width between anterior canthus of eye double length of fissure; external separated by one length of same, which is less than the distance between inner nares.

Tongue small, as in other young, but not fissured or grooved, as in those of the two preceding species. Palatine teeth forming an arched series between nares, extending to their anterior border, and not beyond their inner border in the lateral direction. From their resemlance to those of *A. microstomum* of the same age I suspect they are similar in old individuals.

Body rather slender; width of head at jaws four times in total length to groin, and .75 length to gular fold. Tail short, longer when older, equal from its basis to axilla. Limbs moderately stout; digits elongate; third and fourth toes nearly equal then fifth, second, first. Fingers 3, 2, 4, 1.

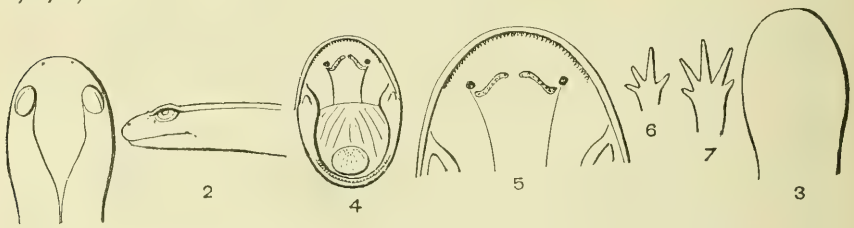

Fig. 20. *Chondrotus texanus*, young. No. 4044. San Antonio, Texas; ♀.

Above, light brown, with a series of light spots along upper part of sides; these are small, and one is between each pair of costal folds. Sides and belly yellow.

Measurements.

	In.	Lin.
Length from end muzzle to canthus oris	0	2.6
Length from end muzzle to axilla	0	6.5
Length from end muzzle to groin	0	14
Length from end muzzle to end tail	2	3.75
Length from elbow to end finger	0	3.1
Length from knee to end toe	0	3.7

No. 4044, eleven specimens; locality, San Antonio, Tex.; collector, J. D. Graham.

The plane front and canthus nostralis of this species form a resemblance to the *C. tenebrosus*, between which and *C. microstomus* it is naturally placed.

CHONDROTUS PAROTICUS Baird.*

Cope, American Naturalist, 1887, p. 88.

Amblystoma paroticum Baird, Cope, Proc. Ac. Phila., 1867, p. 200; Strauch, Salam., p. 65; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 48, Pl. II, fig. 3.

This salamander is of very peculiar character. It is one of the stout-bodied species, in this respect about equal to *A. punctatum*, but with a broader head.

In the type specimen (4708) the skin is remarkably free from pits, pores, and milk glands. These are found on the parotoid region, both above and below the horizontal furrow from eye to side of neck, which is swollen in consequence. There is also a small patch on top of head bordering the orbit, a patch on the spaces between the intercostal furrows, on the upper part of the sides, extending, though faintly, nearly to the belly. Along the ridge of the tail, bordered below by an indented line, the glands are thickly crowded. A few scattered glands are seen along the back; elsewhere the skin is perfectly smooth and glandless, with the muscle directly beneath it, although probably when fresh the usual shallow pits of the group stud the skin thickly everywhere, as usual. These are distinctly visible in a second specimen (4709). In this also the glands are more numerous on the back and extend farther down the side of the tail.

The head is broad and depressed, considerably constricted at the neck. The eyes are unusually large and prominent for the genus, separated anteriorly by about twice the length of their orbits, distant from the nostrils less than this length. The outer and inner nostrils are respectively about equidistant by little more than one length of the orbit.

The tongue is moderate, nearly circular, filling the rami only anteriorly and hardly more than half the width of the head.

The teeth are in four patches, forming a transverse series, slightly angular anteriorly, where they extend to about opposite the centers of the inner nostrils. The two central patches are rather the larger, with a slight interval. They extend postero-laterally nearly to the inner margin of inner nostrils; then are separated from the outer patches by an interval nearly the width of the inner nostrils. The lateral patches extend a short distance beyond the outer margin of the inner nostrils.

*Plate 24, figs. 6, 7.

The para sphenoidal portion of the roof of the mouth is much restricted laterally and behind.

The body is full, rounded, and depressed. There are eleven costal furrows, including inguinal and axillary.

The tail is compressed, but oval in cross-section, with the lower edge rather sharp towards the end. The upper outline is much rounded. It is not high, and not as long as the rest of head and body; longer than from snout to groin. In one specimen there is a distinct furrow along the under side.

The limbs are large; the digits lengthened; more depressed than in *A. punctatum*, but linear, not triangular in shape. The lateral ones are more lengthened than usual, and those of each limb are more nearly of a length. The free portion of longest finger is more than one-third from tip to elbow; that of longest toe in the same proportion.

The gape of the head is wide; the length more than half the width. The width of the head is contained four times in distance from snout to groin.

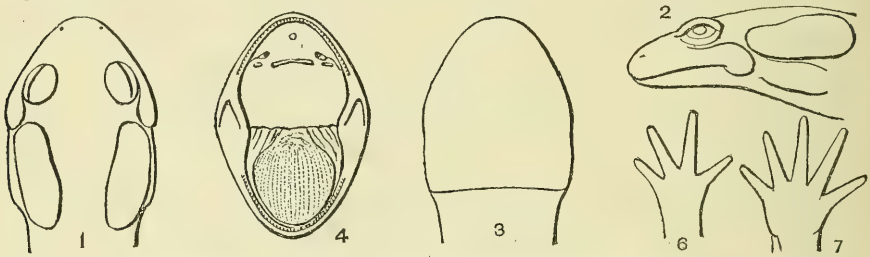

FIG. 21. *Chondrotus paroticus*. No. 7021. Puget's Sound, Oregon. Natural size.

The color in one specimen is everywhere a dull reddish-olive or brown, paler beneath, and without the trace of any spots. No. 4707 is much darker, nearly black.

The *Amblystoma trisruptum* Cope, from Ocate Creek, is similar to the present species in the intervals between the four palatine patches and the glands on the parotid region. The rest of the skin, however, as far as can be ascertained, is glandular, as in *A. punctatum, tigrinum*, etc. The digits, too, are shorter, flatter, more triangular, the lateral and central more unequal. The eyes are much smaller and farther apart. There are twelve costal furrows, not eleven, etc.

Chondrotus paroticus Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4708	1	Chilowyuck Lake, Oregon.	.....	A. Campbell	Alcoholic type.
7021	1	Puget Sound, Oregon.	.....	Dr. C. B. R. Kennerly.....	Alcoholic.
11445	1	Neah Bay, Oregon	.....	J. G. Swan.....	Do.
4709	2	Near Semiahmoo, Oregon.	.....	A. Campbell	Do.
	1	Coal mines of Vancouver Island.	.....	Alden W. Hewson	Do.

Proportional dimensions.

4708. Chilowyuck.

Head:
- Length of gape of mouth to its width ..... more than half.
- Width to distance from snout to gular fold ..... contained 1¼ times.
- Width to distance from snout to groin ..... 4½ times.
- Width to distance from snout to behind anus ..... + 5 times.
- From snout to gular fold contained in distance from snout to groin .... 3½ times.
- From snout to gular fold contained in distance from snout to behind anus ..... +4 times.
- Distance anteriorly between eyes in length of orbit ..... 2 times.
- Distance from eyes to nostrils in length of orbit ..... little over 1 time.
- Distance between external nostrils in length of orbit ..... little over 1 time.
- Distance between internal nostrils in length of orbit ..... about 1 time.
- Width of tongue to width of head ..... little over ½ time.

Limbs:
- Free portion of longest finger contained in distance from elbow to tip 2⅔ times.
- Distance between outstretched toes in length from snout to groin ..... equal.

Measurements, in inches.

Length (measured along axis of body):	
From snout to gape	.50
From snout to gular fold	.95
From snout to armpit	1.50
From snout to groin	3.10
From snout to behind anus	3.80
From snout to end of tail	7.20
Head:	
Width of head	.75
Width of tongue	.40
Length of orbit	.25
Distance between eyes anteriorly	.45
Distance between outer nostrils	.25
Head—Continued.	
Distance between inner nostrils	.24
Tail:	
Height of tail where highest	.45
Breadth of tail where highest	.20
Limbs:	
Free portion of longest finger	.30
From elbow to tip of longest finger	.83
Free portion of longest toe	.35
From knee to tip of longest toe	1.00
Distance between outstretched toes	3.05

CHONDROTUS DECORTICATUS Cope. *

American Naturalist, 1887, p. 88 (February).

Amblystoma decorticatum Cope, Proceeds. Amer. Philosoph. Soc., 1886, p. 522.

This species has a good deal of affinity in its character to the *C. paroticus* Baird, but it differs in important points of structure, as well as in its external appearance.

Its general proportions are not slender; and the limbs, especially the posterior ones, are very stout. The tail is long, and is compressed from the base. It does not bear a fin at any part. Its length, in the single specimen before me, is equal to that of the head and body (including the vent), less the distance from the eye to the end of the muzzle. The head is short and the muzzle is contracted, and is steeply rounded in profile. The distance from the muzzle to the axilla enters the length from the axilla to the groin 1½ times. The width of the head enters

* Plate 24, figs. 8, 9.

the total length to the groin 4 times. The limbs when pressed to the side overlap by the length of the fingers.

There is no canthus rostralis, and the lower jaw does not extend beyond the upper. The external nares are almost terminal, and are as far apart as the distance between the inner borders of the choanæ. The latter are rather large, and are transverse. The vomeropalatine series of teeth form a short transverse line, which is entirely within the internal borders of the inner nares and a considerable distance posterior to them. The tongue is wider than long, but does not fill the wide floor of the mouth laterally. A dermal groove extends posteriorly from the eye to the side of the neck above the anterior border of the humerus. A branch groove descends a short distance posterior to the eye and turns forwards to the canthus of the mouth. These grooves divide masses of crypts, those on the inferior side of the groove being most prominent. The tract above the groove resembles the parotoid gland of the *Chondrotus paroticus*, but is much less distinctly defined, fading out upwards.

There are eleven well-defined lateral dermal folds, and space for a twelfth, which will probably be found well defined in other specimens. The back from the interscapular region posteriorly and the superior

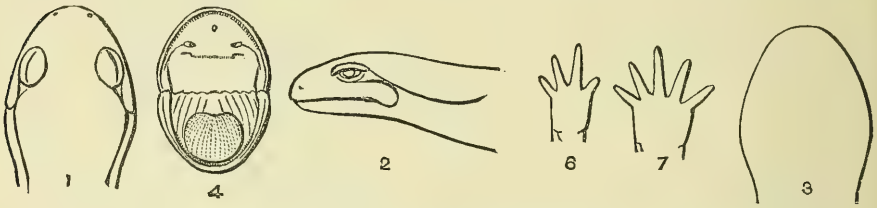

FIG. 22. *Chondrotus decorticatus.* No. 14493. Port Simpson, B. C. Natural size.

part of the tail are thickly studded with crypts. There is a slightly defined gular fold.

The fore limb is as long as from its anterior base to the anterior margin of the eye. The toes are quite short, and their lengths, beginning with the shortest, are 5–2–3–4. The posterior foot is especially robust, and the sole is wider than the length of the longest finger. There are no distinct tubercles on the sole. The lengths of the toes are, beginning with the shortest, 1–5–2–4–3.

Measurements of No. 14493.

	M.
Total length	.174
Length to base of tail	.090
Length to groin	.071
Length to axilla	.031
Length to line of eyes	.005
Length of fore-leg	.026
Length of fore-foot	.010
Length of cubitus	.008
Length of hind leg	.026

	M.
Length of hind foot	.0105
Width between nostrils	.005
Width between eyes	.006
Width of head	.016
Width of sole	.008
Depth of tail at middle	.008

The manner of describing the color pattern of this species depends on what we regard as the ground. We can assume that the ground color is represented by a dark chocolate-brown, and say that this is closely studded with brownish-white spots of irregular forms and sizes. On the back, limbs, and top and sides of the head the pale spots are so close together as to reduce the brown to a net-work. On the fore-legs the pale spots are larger than anywhere else. The spots are few on the tail, and those chiefly near the base. The inferior surfaces are dirty light-brown.

The characters which separate this species from *C. paroticus* are: The much shorter series of vomeropalatine teeth, the shorter fingers and toes, the less distinct parotoid glands, the shorter and more obtuse head, and the coloration.

No. 14493; one specimen; Port Simpsor Alaska, 1885; Dr. T. H. Streets, U. S. Navy.

CHONDROTUS ATERRIMUS Cope.*

American Naturalist, 1887, p. 88.

Amblystoma aterrimum, Cope, Proc. Ac. Phila., 1867, p. 201; Strauch, Salam., p. 65; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 49.

This is a stout species, having a form of head intermediate between that of the *C. tenebrosus* and *A. tigrinum*. The dentition is quite peculiar, and with the *ensemble* of its characters refers this species to the immediate neighborhood of the *C. tenebrosus*.

Head a broad oval, its greatest width a little over three-quarters the length from end of muzzle to gular fold, and 4.2 in same to groin. The pupil marks three-sevenths the distance from canthus of mouth to external nostril. Fissure of orbit equal length from same to nostril and enters 1.66 times width between the latter; it is contained 2.25 times in width between anterior canthi of eyes. Canthus rostralis marked at orbit, terminating very obtusely at nostril. The profile descends steeply from line of latter, not being prolonged, as in *C. tenebrosus*. Thus from the line connecting middle of inner nares to lip is .75 external internarial distance and .6 between anterior canthus of eyes; in *C. tenebrosus*, same equals internarial width and .75 the distance between eyes. The distances between inner and outer nares are the same; the former are round. The series of palatine teeth commence only opposite the middle of the posterior margin of the internal nares, and describe a slight curve

* Plate 24, figs. 4, 5.

round their inner margins to a point just in advance of their anterior, then turn abruptly inwards and slightly backwards, making a right angle with their previous course. They converge, but do not unite.

Tongue large; as broad as long. Gular fold well marked; parotoid groove not visible, perhaps accidentally. It is difficult, as in the *C. tenebrosus*, to distinguish the costal folds. There are not more than twelve.

The tail is short and stout; its upper edge is much compressed, as is the posterior half; its glandular structures are much less developed than in other species of Amblystoma, the crypts of the crest being minute and globular. Length of tail equal from its origin (posterior margin vent) to posterior outline of sternum.

The extremities are very stout, just meeting when laid along the side. The palms and soles are very wide, and the toes short and flattened. They stand, as regards length, behind, 3, 4, 2, 5, 1; before, 3, 2, 4, 1.

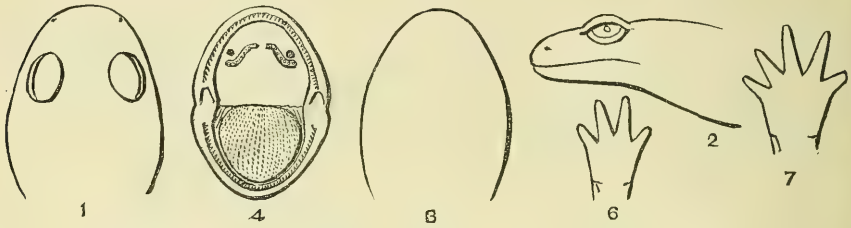

FIG. 23. *Chondrotus aterrimus*, No. 5242; natural size; Rocky Mountains.

The color is black above, lead colored below.

Measurements.

	In.	Lin.
Length from snout to gape (flat projection)	0	7.1
Length from snout to gular fold	0	12.75
Length from snout to axilla	0	19.1
Length from snout to groin	0	39
Length from snout to end of vent	0	48
Length from snout to end of tail	6	6
Width of head	0	9.75
Width of tongue	0	5.2
Width between eyes anteriorly	0	5
Width between nostrils	0	4
Width between inner nostrils	0	3
Width from eye to nostril	0	2.25
Circumference of belly	0	23.6
Greatest height of tail	0	5.4
Greatest width of tail	0	4.5
Free portion of longest finger	0	2.5
From elbow to tip of finger	0	9.75
Free part of longest toe	0	3
Knee to tip of longest toe	0	11
Extent of outstretched toes	0	6.6

No. 5242; one specimen; North Rocky Mountains; Lieutenant Mullen.

CHONDROTUS TENEBROSUS Bd. Gird.

(Plate 22–23; 24, figs. 1–3.)

Cope, American Naturalist, 1887, p. 88.

Amblystoma tenebrosum, Baird and Girard, Proc. Ac. Phila., 852, p. 174, and U. S. Expl. Surv., XII., part II., Pl. 31, fig. 1; Cope, Proc. Ac. Phila., 1867, p. 202; Strauch, Salam., p. 65; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 49.
Xiphonura tenebrosa, Gir., U. S. Expl. Exped., Herp., p. 14, Pl. I, figs. 9–17.

This species is especially characterized by its massive frame and huge size among true salamanders, as well as by other peculiarities, hereafter to be mentioned.

The skin is less glandular than in *A. punctatum* or *tigrinum*, although scattered glands may be detected closely and evenly distributed on the whole back and sides and on the chin. The remaining under parts and snout before the eyes are smooth.

The head is very massively built, large, broadest behind the eyes and triangular, the sides being nearly straight to the narrow and rounded tip. The eyes are very large and prominent, separated by less than two lengths of the orbit, and distant less than one length from the outer nostrils, which are separated by $1\frac{1}{4}$ orbits distance, and placed on the side below the distinct canthus rostralis. The outer nostrils are much more distant than the inner, which are very large, much excavated, and have the external canal occupied by a soft, plaited membrane.

The tongue is thick and fleshy, nearly orbicular, but angular anteriorly. It fills up the lower jaw pretty well, and is more than half the width of the head.

The palatine teeth are in two patches only; each very slightly convex anteriorly, coming together at a slight angle, with the apex backward, but separated along the median line. Laterally the patches of teeth form the posterior margin of the inner nares, and do not extend beyond their outer margin. The entire series is thus posterior to the nostril. In younger specimens the series are more transverse, the inner extremities slightly incurved.

The width of the head is contained $1\frac{1}{3}$ times in distance to gular fold and 4 times to groin.

The body is rounded and depressed. As nearly as can be ascertained there are about twelve costal furrows.

The tail in the two specimens before me is considerably less than half the total length. It is much compressed from near the base, and the edges near the end are quite sharp. It is far short of being as deep at the base as the body.

The limbs are stout. The digits, the fingers especially, are short, considerably depressed, but linear and blunt at the tips. The under surfaces of these are somewhat swollen into a kind of bulb, which in alcohol contracts into something the appearance of a disk. The third finger is

longest, but is very little more than the second, and this than the first and fourth. The third finger is contained nearly four times in the distance from elbow to tip. The fourth toe is longer than third in three specimens; in one the second exceeds the fourth a little, and the same are nearly equal in case of the fingers.

The color of this species in alcohol is a kind of dark reddish-brown; paler beneath, mottled and marbled above, and on the sides with darker brownish; most distinct on the head, especially on the snout, where the skin is perfectly smooth. The head shows a tinge of grayish in the ground color.

(For fresh color see the figure in Girard's Herpetology of the United States Exploring Expedition.)

There are two varieties of this species: α. Where the loreal region is flat and the muzzle narrower before the orbits, and the marblings confined to the head; the body being of a nearly uniform brown. Represented by specimens 4710 and 4053. β. The loreal region swollen in front of orbits, and hence the muzzle broader; the ground color grayish, with coarse brown marbling, like large hollow spots, distributed over the whole upper surfaces of the body and tail. Represented by No. 5981 and a large specimen (length 8 inches 6 lines) in Mus. Philadelphia Academy of Natural Sciences, from Body Bay, latitude 38° 18′ north, on the coast of California, procured by George Davidson, of the U. S. Coast Survey.

Chondrotus tenebrosus Bd. Gird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4710	1	Oregon		Exploring expedition	Alcoholic type.
4053	1	Astoria, Oregon		Lieut. W. P. Trowbridge, U. S. Army.	Alcoholic.
5981	1	Chilowyuck Lake, Oregon.		Dr. C. B. R. Kennerly	Do.
14482	1	Puget Sound, Oregon		do	Do.
14491	1	Portland, Oregon	1885	J. Levison	Do.
14559	1	Shasta County, Cal.	1886	L. W. Green	Do.
13781	7	do	1885	Chas. Townsend	Ad. and larvæ.

Proportional dimensions.

Head:

Length of gape of mouth to its width ..... two-thirds.
Width contained in distance from snout to gular fold ..... 1¼ times.
Width contained in distance from snout to groin ..... 4 times.
From snout to gular fold contained in distance from snout to groin ..... little over 3 times.
Distance anteriorly between eyes in length of orbit ..... not quite twice.
Distance from eyes to nostrils in length of orbit ..... four-fifths.
Distance between external nostrils in length of orbit ..... 1⅓ times.
Distance between internal nostrils in length of orbit ..... four-fifths.
Width of tongue to width of head ..... one-half.

Limbs:

Free portion of longest finger contained in distance from elbow to tip ..... nearly 4 times.

Free portion of longest toe contained in distance from knee to tip ..... nearly 3½ times.

Distance between outstretched toes in length from snout to groin ..... one-third.

Tail:

Length from behind anus to rest of animal ..... contained 1½ times.

Length from behind anus to total length ..... two-fifths.

Measurements in inches.

Length, measured along axis of body:		Body:	
From snout to gape	.80	Circumference of belly	4.00
From snout to gular fold	1.50	Distance between armpit and groin	2.65
From snout to armpit	2.10	Tail:	
From snout to groin	4.55	Height of tail where highest	.65
From snout to behind anus	5.65	Breadth of tail where highest	.36
From snout to end of tail	9.30	Limbs:	
Head:		Free portion of longest finger	.28
Width of head	1.15	From elbow to tip of longest finger	1.05
Width of tongue	.60	Free portion of longest toe	.36
Width of orbit	.34	From knee to tip of longest toe	1.35
Distance between eyes anteriorly	.58	Distance between outstretched toes	3.60
Distance between outer nostrils	.40		
Distance between inner nostrils	.30		
Distance from eye to nostrils	.26		

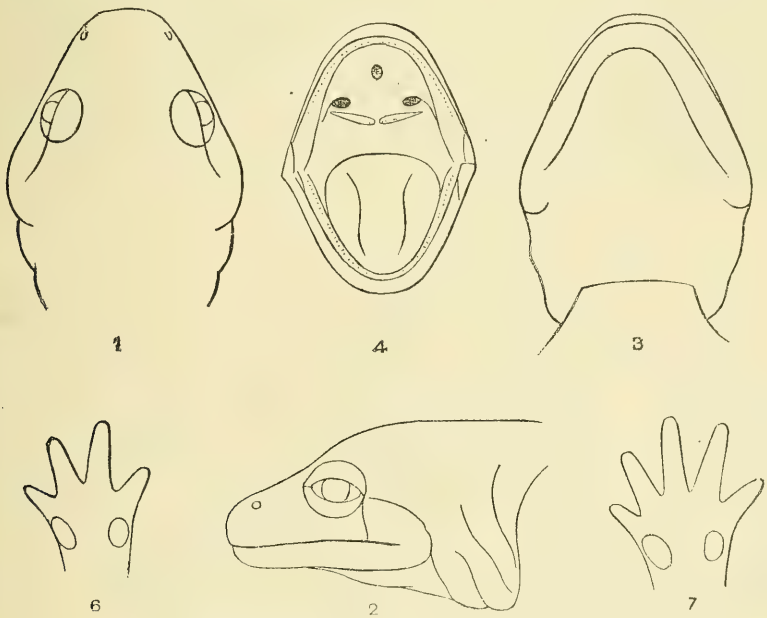

FIG. 24. *Chondrotus tenebrosus*. 4053. Astoria. ½.

The larva of this species frequently exceeds in dimensions that of any other species, and quite equals the adult. It is a uniform lead color,

or sometimes blackish, and the muzzle is rather abruptly shortened. The tail has a fin at its extremity, which extends also well anteriorly on the superior edge. The digits are flattened, and their apices are protected in many specimens by a horny cap of a blackish color. This larva, however, differs from that of other species of the genus in other characters of more importance. First. There are no teeth on the splenial bone. (I have not examined very small specimens.) Secondly. The branchiæ have a peculiar shape.* There are no processes such as exist in all other Urodele larvæ, but the fimbriæ arise from the edges of the vertical laminæ, which separate the pharyngeal fissures (Fig. 3, p. 3, No. 7). The superior part of the lamina is a little more produced than the inferior, so as to form in some specimens, on the third lamina, a short process. This type of external branchiæ does not resemble any of those of the perennibranchiate types, where there are always processes which are frequently furnished with more or less numerous rami. Thirdly. The teeth of the larva are stronger than in the adult. They are compressed, double-edged, and acute, having thus a dagger-shape. They can inflict a severe bite.

As they approach maturity the marbled colors begin to appear. They can probably reproduce without undergoing a metamorphosis, since I have found eggs in the ovaries ready for deposit.

I observed these larvæ in some tributaries of the McCloud River, near Baird, Cal. They swam with great rapidity, darting about and hiding themselves among the fallen leaves that covered the bottom. I took from the stomach of one of them a larva of its own species of one-third its size. They are common in the mountain streams of northern California and western Oregon. The skeleton of a large specimen from Salem, Oregon, is figured on Plates 20–21.* The hyoid apparatus of a younger larva is represented on Pl. 22, figs. 2–3.

LINGUÆLAPSUS Cope.

American Naturalist, 1887, p. 88.

Otoglossal cartilage free from the basibranchial, and capable of anteroposterior movement on it, and not forming a ring. Tail cylindric.

In other respects this genus is identical with Amblystoma. The difference in the otoglossal cartilage is great, and is presented under modifications by two species. This cartilage is drawn backwards by two pubohyal muscles, and forwards by two corresponding geniohyals. (Plate 22, figs. 10–13.)

The species of Linguælapsus resemble in the character of their tongue and vomerine teeth the type of *C. microstomus* and the genus Chondro-

* See page 31, antea.

* The fourth ceratobranchial was present in this specimen, but was overlooked by the artist.

tus. They are the only Amblystomidæ with cylindric tail. They differ as follows:

I. Folds of the tongue radiating from a longitudinal furrow; vomerine teeth not extending external to internal nares; tail rounded in section.

α Cornua of otoglossal cartilage turned forwards; muzzle very short; jaws equal; legs short, separated from each other, when appressed, by four interspaces; blackish, with light cross-bands on head, body, and tail. *L. annulatus.*

αα Cornua of otoglossal cartilage turned backwards; muzzle elongate, projecting beyond chin; legs longer; separated, when appressed, by two intercostal spaces; grayish-brown, with numerous pale transverse lines, which form a reticulate pattern across the tail ..... *L. lepturus.*

LINGUÆLAPSUS ANNULATUS Cope.*

American Naturalist, 1887, p. 88.

Amblystoma annulatum Cope, Proc. Amer. Philos. Soc., 1887, p. 525.

This species resembles the *Chondrotus microstomus* rather than the *C. cingulatus* or the *L. lepturus*. However, it approaches the last-named species in the form and length of its tail, and exceeds that and all the other species of the family in the length of that part of the body.

The muzzle is very short, and the head is not distinguished from the neck. The legs are short, and when appressed to the sides are separated by a space of three and parts of two other intercostal spaces, equal to four spaces. The tail is in section cylindric at base, and widely oval to near the extremity, where it is more narrowly oval. It is not angulate, and has no dermal margin on the middle line above or below. Its length exceeds that of the head and body by the length of the anterior foot, and it may have been longer, as the extremity is injured.

The head is short, and the width enters the length to the groin six and a quarter times. The front is convex to the upper lip or profile, and transversely between the orbits. The parietal region is very convex transversely. The width between the canthi oculorum behind exceeds the length from the same point to the end of the muzzle. The nostrils present anteriorly, and they are not quite so close together as in the

FIG. 25. *Linguælapsus annulatus.* No. 11564; natural size, except Fig. 5.

L. lepturus, as the distance between them measures two-thirds the width between the eyelids. The vomerine teeth form two transverse fasciculi, of several rows of teeth each, between the choanæ, convex forwards, and separated on the middle line by a very short interval.

The skin is perfectly smooth. There is a postgular fold, and the sides are crossed by thirteen folds, with space enough at the axilla for

* Plate 24, figs. 10, 11.

a fourteenth. The tail is also very distinctly annulate-grooved. I count thirty-one grooves behind the femora, and the injured extremity is not grooved. Indistinct grooves are apparent on the tails of several of the species of Amblystoma. There are no rows of mucous pores on the head or body of this species, nor accumulations of crypts on the head, body, or tail.

The palm is wide, and the fingers not long, though of unequal length. The lengths of the fingers, beginning with the shortest, are, 2, 5, 3, 4, and their phalanges, 2, 2, 3, 2. The toes of the hinder foot are, in order of length, 1, 5, 2, 3, 4; and the phalanges, 2, 2, 3, 4, 2.

This species is larger than the *L. lepturus* or the *Chondrotus microstomus*.

Measurements.

	M.
Total length	.186
Length to base of tail	.092
Length to groin	.077
Length to axilla	.022
Length to canthus oris	.009
Length of fore limb from axilla	.0172
Length of fore-foot	.007
Length of hind limb from groin	.022
Length of hind foot	.012
Width of head	.012
Depth of tail at middle	.009

The typical and only specimen is preserved in alcohol. The color above everywhere is dark brown; below, very light brown. The sides are paler, perhaps pale yellow in life, and the color ascends at several points, so as to form cross-bands of moderate width and very well defined. One of these crosses at the occiput and one at the axillæ; between the latter and the groin there are five, nearly equidistant. There is an imperfect one at the sacrum, and there are seven on the tail, one of them imperfect. The coloration of this species is quite unique in the genus in its regularity.

The locality of the only specimen, No. 11564, is unknown.

LINGUÆLAPSUS LEPTURUS Cope.*

American Naturalist, 1887, p. 88.

Amblystoma lepturum Cope, Proc. Amer. Philsoph. Soc, 1886, p. 524.

This species resembles the *Chondrotus cingulatus*, but differs from it in the entirely different form and proportions of the tail. This part is very slender in the *L. lepturus*, with round or vertical oval section, without keel above, and lacking very little of being as long as the head and body together. The legs are of the same proportions as in the *C. cingulatus;* that is, when appressed they are separated by a space equal to the length of the posterior foot, showing their greatly superior length to those of the *C. microstomus*. The body is cylindric. The head is

* Plate 24, figs. 12, 13.

an oval, with produced and rounded muzzle, which projects beyond the lower jaw. The animal resembles a Plethodon rather than the species of Amblystoma, but its vomerine teeth and tongue have all the characters of the *Chondrotus microstomus*.

The vomerine teeth form a convex series, extending forwards to a point between the choanæ, where they are slightly interrupted on the middle line. The tongue is large, filling the floor of the mouth, and is extensively free at the sides only. The external nostrils are nearly terminal and are rather near together, the space between them being equal to just half that between the bases of the eyelids and about three-fifths that between the choanæ. The width between the eyes behind is equal to the axial length from the same to the end of the muzzle. The width of the head enters the length to the groin seven times. The length from the muzzle to the axilla enters the distance from the latter to the groin $1\frac{3}{5}$ times.

The lateral digits are distinct and the median ones moderately elongate. Their lengths, beginning with the shortest, are: Fore-foot, 2, 5, 3, 4; hind foot, 1, 5, 2, 3, 4. The phalanges are: Fore-foot, 2, 2, 3, 2; hind foot, 2, 2, 3, 4, 2. No palmar or plantar tubercles.

The skin is perfectly smooth, and between the axilla and the groin it is marked by fourteen grooves. There are no dermal margins to the fingers or the tail. The cloacal orifice is a simple slit. There is a distinct postgular fold.

FIG. 26. *Linguælapsus lepturus*. Nat. size, except fig. 5.

Measurements.

	M.
Total length	.115
Length from end of muzzle to base of tail	.092
Length from end of muzzle to groin	.0515
Length from end of muzzle to axilla	.020
Length from end of muzzle to canthus oris	.0065
Length of fore-leg	.013
Length of fore-foot	.0055
Length of hind leg	.016
Length of hind foot	.0075
Width of head	.0075
Depth of tail at middle	.0025

The color of the typical specimen in alcohol is purplish-brown above and paler below. There are numerous not well-defined whitish spots on the sides and a few on the belly, and there are some very faint and delicate gray lines across the posterior part of the back. The tail is densely speckled with gray on the sides, and delicate gray lines across

the upper surface of the tail in a reticulate manner. The limbs are paler than the back, and the digits are cross-barred with whitish.

The habitat of this species is unknown. The only specimen was found in a jar with a specimen of *Diemyctylus torosus* and one of *Rana temporaria;* the former Californian, the latter Palæarctic.

DICAMPTODON Strauch.

Strauch, Salam., p. 68; Boulenger, Cat. Batr. Grad. Brit. Mus., 2d ed., 1882, p. 38.

Tongue nearly entirely adherent. Palatine teeth in two long transverse arched series, convex forwards, converging backwards, situated behind the line of the choanæ, separated from each other by a wide interspace. Toes five. Tail compressed.

This genus I have not seen. Its characters and those of its only species are copied from Boulenger's work above quoted.

DICAMPTODON ENSATUS Esch.

Strauch, *l. c.*, p. 69; Boulenger, Cat. Batr. Grad. Brit. Mus., 2d ed., 1882, p. 38.

Triton ensatus, Eschscholtz, Zoöl. Atlas, p. 6, Pl. 22.

Head broad. Snout rounded. Body stout. Limbs short. Toes free. Tail sword-shaped, curved upwards, as long as head and body. Skin nearly smooth; parotoids and costal grooves apparently absent. Reddish-brown; back marbled with brown. Total length about four decimeters.

I have not seen this species, and know it only from the figures and descriptions above cited. It is said to come from California.

HYNOBIIDÆ.

Hynobiidae Cope, proc. Acad. Phila., 1859, p. 125.

Otoglossal cartilage, none; a second epibranchial. Second basibranchial not continuous with the first.

Vertebræ amphicœlous.

No parasphenoid teeth; vomerines on the posterior edge of the vomeropalatine bone. Pterygoid bones distinct.

According to Wiedersheim* two genera of this family, Hynobius and Ranidens, possess a lachrymal bone in addition to the prefrontal. Whether it is a characteristic of the other genera remains to be ascertained. The same author shows (*l. c.*) that the hypohyal cartilages are very elongate in the two genera named, and are not articulated with the basibranchial, thus permitting of independent motion. (See Plate 25, figs. 10–11.) He also figures a cartilaginous connection between the stapes and the quadrate, as occurs in the Trematodera, which is a character of much importance.

* Das Kopfskelet der Urodelen, pp. 66–71.

The latest work on this subject, that of Boulenger, throws much light on it, owing to the opportunities enjoyed by its author for the study of the forms of salamanders found in Asia. He gives the following table of the genera of the family, but refers them all to the Amblystomidæ:

I. Series of palatine teeth converging backwards, forming a V-shaped figure.
  Toes five ..... *Hynobius.*
  Toes four ..... *Salamandrella.*
II. Series of palatine teeth uninterrupted, doubly arched, forming a ᗰ-shaped figure.
  Fingers and toes with epidermic claws ..... *Onychodactylus.*
III. Series of palatine teeth in two arches, convex forwards, separated by a wide interspace.
  Palatine series short, between the choanæ. Toes five ..... *Ranidens.*
  Palatine series short, between the choanæ. Toes four ..... *Batrachyperus.*

Of these genera all are Asiatic. The horny claws said to characterize Onychodactylus may not be confined to that genus or be constant in it, as they develop by the hardening of the epidermis in Amblystoma and some other genera on exposure to dry conditions.

There are twelve species of this family known, distributed as follows: Hynobius 5; Salamendrella 2; Onychodactylus 1; Ranidens 3; Batrachyperus 1. The hyoids of three of these genera have not been examined.

PLETHODONTIDÆ.

Gray, Cat. Batr. Grad. Brit. Mus., 1850, 31, exclusive of Amblystoma and Desmognathus.

Plethodontidæ Cope, Journ. Ac. Nat. Sci., Phila., 1866, 105.
Spelerpinæ Cope, Proc. Ac. Nat. Sci. Phila., 1859, 123.
Plethodontidæ Bolitoglossidæ and *Hemidactyliidæ* Hallow., Journ. Ac. Nat. Sci., Phila., 1858, 338, 339.
Plethodontinæ Boulenger, Catal Batr. Grad. Brit. Mus. ed. II, 1882.

Vertebræ amphicœlous, simple below. Ethmoid wanting; no pterygoid.

Carpus and tarsus cartilaginous.

Vomeropalatine bones not produced posteriorly over parasphenoid; dentigerous plates on the parasphenoid.

Ceratohyal undivided, articulating directly with the quadrate bone or cartilage; no otohyal. One only, the first epibranchial in adults; second basibranchial not connected with the first.

Stapes not connected with the quadrate by cartilage, in adults.

Vestibule, inner wall osseous.

The above characters define a very distinct and natural group of genera, which are all but one (Geotriton) confined to America. Many of the species are of small size, some of them indeed of very small size. The largest species, *Spelerpes bellii*, reaches the dimensions of the *Amblystoma tigrinum* or Axolotl. Some of the species are hand-

somely colored. All are distinguished for their power of projecting the tongue. Some of the species of Spelerpes, where this organ is free all round, can project it entirely from the mouth, while the *Geotriton fuscus* has almost the power of the chameleon in this respect, projecting the tongue for a distance equal to one-half the entire length of the animal.*

Appropriately to this habit, the basibranchial bone and its pair of short hypohyal processes are free from the ceratohyals, thus admitting of free movement, and the epibranchials are very long. In all of the genera the extremity of the ceratohyal is attached to the quadrate, as in the Amblystomidæ, showing that it is not this element which is projected. But in Geotriton and Spelerpes sp. the epibranchial is greatly elongate, extending to the side of the nape and interscapular region, a structure necessary to projectility.

In the characters of the scapular and pelvic arches this family does not differ from the Amblystomidæ and Salamandridæ. The foramen which separates the procoracoid from the coracoid is well marked and intermarginal; in the Amblystomidæ it is smaller, and in the Salamandridæ marginal. The femur always presents a strong trochanter. It is weak in *Stereochila marginatum*. In Triturus and Diemyctylus it is quite weak, but in Salamandra strong.

In most of the genera of this family the enamel does not cover the entire crown of the tooth. In *Spelerpes ruber*, *longicaudus*, and *bellii*, and *Plethodon glutinosus* and *cinereus* the external part of the crown terminates in a transverse cutting edge, while the inner extremity is more prolonged, leaving a transverse depression between the two. In *Sp. bellii* the inner apex is transverse and prolonged a little beyond the external, while in the other Spelerpes and the *Plethodon glutinosus* the inner crown is more prolonged and is incurved conic. In *P. cinereus* it is a little more obtuse. In Desmognathus and the Amblystomidæ the two apices are of equal height and are both transverse cutting edges, the outer narrowed in the former. In the larvæ of Plethodontidæ that I have examined the crowns are simple. The teeth of Autodax are more like those of Cœcilia, or of Hylonomus of the Coal Measures, and distinguish the genus from other Plethodontidæ.† They are large, compressed, and simple.

This family is more remote in its skeletal characters from the Salamandridæ and Pleurodelidæ than is the Amblystomidæ. Thus the absence of parasphenoid brushes, the ossification of the tarsus and carpus, and the persistence of the pterygoid bones are characters common to the two latter and wanting in the present family. On the other hand, the non-prolongation posteriorly of the vomers, the articulation of the ceratohyal with the quadrate, and the amphicœlous vertebræ belong to this family and the Amblystomidæ only. The position of the

* Rüdinger in Sitzungsber. Akad. Wiss., Munich, 1885, p. 109.

† See Proceed. Acad. Nat. Sci., Phila., 1859, 124.

latter family is, therefore, between the Plethodontidæ and the Salamandridæ. The Amblystomidæ and Plethodondidæ may be thus compared with reference to the developmental character of the features which distinguish them.

AMBLYSTOMIDÆ.	PLETHODONTIDÆ.
Superior.	*Inferior.*
Carpus and tarsus osseous.	Carpus and tarsus cartilaginous.
Premaxillary fontanelle closed.	Premaxillary fontanelle open.
Inferior.	*Superior.*
O. pterygoideum persistent.	*O. pterygoideum* obliterated.

The inferiority of some Plethodontidæ is seen in the non-distinction of the digits (Œdipus), the thinness of the ossification of the parietal membrane bones (Batrachoseps), and in Œdipina the persistence of the membranous cranium by the limitation of the parietal bones to two small oval lateral scales and the wide divarication of the posterior extremities of the frontals.

The genera embraced in this family are as follows:

Section I. The tongue attached from the central or posterior pedicel to the anterior margin in narrower or wider band. (Plethodontæ.)

A. Two premaxillary bones.

Digits 4, 5; maxillary bone regular, with numerous small teeth; parietals fully ossified ..... *Plethodon.*

Digits 4, 4; maxillary as above, parietals fully ossified..... *Hemidactylium.*

AA. One premaxillary.

α. Digits 4, 4.

Maxillary regular, with small teeth; parietals not ossified... *Batrachoseps.*

αα. Digits 4, 5.

Maxillary normal; teeth small, very numerous; no premaxillary fontanelle ..... *Stereochilus.*

Maxillary edentulous posteriorly, decurved, forming a cutting edge; teeth few, large, knife-shaped; a premaxillary fontanelle..... *Autodax.*

Section II. The tongue free all round; attached by its central pedicel only. (Spelerpes.)

A. Two premaxillary bones (with fontanelle).

Digits 4, 5, closely united by a broad palmar membrane ..... *Geotriton.*

Digits 4, 5, entirely free ..... *Gyrinophilus.*

AA. One premaxillary bone (with fontanelle).

α. Digits 4, 4.

Digits free; parietal and palatine bones well ossified..... *Manculus.*

αα. Digits 4, 5.

Digits all free; cranial bones well ossified ..... *Spelerpes.*

Digits little distinct; parietal and palatine cartilages not ossified. *Œdipina.*

Digits entirely confounded as an undivided palm or sole; cranial bones well ossified..... *Œdipus.*

The generic relationships of the above-named groups are exceedingly simple, and the ease with which the animals can be analyzed renders the case free from the doubts which constantly arise in discussions of generic relationships as to the probable omission of characters

from the argument. Here it can be safely asserted that, as far as the skeletons are concerned, there exist no other generic distinctions than those given above. If, now, any principles can be derived from consideration of the osseous system, that which of all others presents us with by far the greatest number of minute modifications of structure, the same may be with considerable probability inferred for the other systems.

The primary groups are distinguished by the different degrees of attachment of the tongue. That form which is most attached represents and is identical with an immature stage of the species of section second, where it is more extensively free, as any one may satisfy himself by the examination of a larva of Spelerpes at a certain period. The tongue will be found to be that of Plethodon.

The secondary groups are distinguished by the separation or confluence of the premaxillary bones. Those presenting the latter type exhibit separate premaxillaries at the beginning of larval life, though the union often takes place very early. The number of digits distinguishes groups of genera of less value; in some the hind limb has five digits, in others four. In an early larval stage all possess but four digits, and in some of those with five the inner consists of one phalange only even at maturity (*Spelerpes chiropterus et. aff.*) Not having as complete a series of larvæ of Spelerpes and Plethodon as of *Amblystoma punctatum*, I describe the development of the digits in the latter as indicating the meaning of variations in the same at maturity. At a length of 1.2^{mm} the fore limb only is projected, and bears two digits only, as in the genus Proteus. At 1.5^{mm} sometimes the posterior limbs are developed, sometimes not, and from this size to 2.5^{mm} the number of digits bears little relation to the size of the animal, an additional digit sometimes appearing earlier, sometimes later. Their numbers are then at first 2–0; then always 3–0. With the hind foot divided, they are 3–2, and then 3–4. Sometimes the anterior digits are complete in number before the hind limb appears, and we have combinations of numbers from 4–0 to 4–3, 4–4, and the full number, 4–5, which is found in all specimens of 2.5^{mm} and upwards. Genera which exhibit reduced digits are in *all* other respects Spelerpes (*i. e.* Manculus) or Plethodon (Hemidactylum), or Hemidactylium with unossified parietal bones and consolidated premaxillaries (Batrachoseps). Applying the case of Amblystoma to these, we could not assert that Hemidactylium, for instance, is *identical* with the undeveloped stage of Plethodon, since when Amblystoma exhibits digits 4–4 it is branchiferous. But making the more legitimate comparison with Plethodon itself, I find that the complete number of posterior digits appears much later in life than in Amblystoma, while the branchiæ are absorbed much earlier; that development in the first regard is retarded, while in respect to the gills it is accelerated. Thus in *Plethodon cinereus* the exterior digit is longer than the interior; in specimens of 2.4^{mm} the outer digit is the shorter; in those

of 1.8mm, which are without gills, it is a very minute tubercle on the outer metatarsus. In a little earlier stage it can not but be wanting, though this I have not seen, and I have little doubt that it is then a Hemidactylium, unless, indeed, the parietal bones be not ossified.

Another fœtal condition rendered permanent is seen in the generic character of the genus Œdipus, which differs from Spelerpes solely in the fœtal non-separation of the digits which continues even after the bones of the digits have been developed. In the larva of *Sp. ruber* the digits are early entirely distinct, so that so far as this species is concerned Œdipus presents an *inexact parallelism*, but they are also more distinct than in the mature *Spelerpes bellii*, where, as might be supposed, the fœtal union is delayed to maturity in other respects, as in a specimen from Orizaba, Mexico, of 16.5 lines in length. There the union is about as extensive as in *Œdipus morio*. In the young of *Thorius pennatulus*, the digits are not distinguished in specimens of .66 of the full size, and otherwise entirely mature. In the adult they are distinct for half their length. The digits in the young larva of *Gyrinophilus porphyriticus* are as distinct as in those of *Spelerpes rubra*. In one example I find the simple foot of earlier stages retained, resembling exactly that of Œdipus, excepting that there are emarginations for but three toes instead of five. Genera which have no premaxillary fontanelle at maturity have it in the larval stage. Finally, closely allied genera, which only differ in the degrees of ossification of the parietal and palatine bones, represent simply the relation between undeveloped and developed conditions of the same form.

The relations of the genera may be expressed as follows: Those of the first or Plethodontine section are related to those of the second or Spelerpine by an *inexact parallelism*, excepting Autodax, whose peculiarities exclude it from the comparison. Those in each section differing in the union or separation of the premaxillary bones are related in the same way to each other. The nearly allied genera in the Plethodontine group are Hemidactylium and Plethodon, and Batrachoseps and Stereochilus. In the first case we have only inexact parallelism, because while Plethodon has the four digits of Hemidactylium, its parietal bones are unossified, though an acceleration of development in these respects would render the relations one of *exact parallelism*. This is apparently the relation between Batrachoseps and Stereochilus, for with the fœtal digits of the latter the former preserves also its fœtal cranium. It only remains to ascertain whether Stereochilus loses its branchiæ before or after acquiring the normal number of digits. From the very small size of one at least of these the former case seems probable, but I have not yet been able to prove it by direct observation. Should it be so, we would have a case of *exact parallelism*.

In the Spelerpine group the relation between Geotriton and Gyrinophilus is again one of *inexact parallelism*, since when the digits of the latter are only separated at the extremities, as in the former, the

animal is still branchiferous and possesses the larval tongue, etc. The same occurs in Spelerpes when certain of its species present but four hind toes, as in Manculus; therefore the relation of these two is also of inexact parallelism. The relation of Thorius is also one of *inexact parallelism*, for though its characters are found in some young Spelerpes at an immature age subsequent to the absorption of the branchiæ, it has opisthocœlus vertebræ. With Œdipus, if the condition be not that of *exact parallelism* with some species of Spelerpes, the approach to it is close, as above observed. It is chiefly prevented by the fact that the ossification of the parietal bones in most species of the latter takes place after the extremities are fully developed. It is to be observed in this connection that, as has been above pointed out, the separation of the digits takes place at very different periods in the history of the different species of the same genus. Thus in the *Spelerpes ruber* they are entirely distinct at a very early period of larval life, while in *S. cephalicus* and *S. bellii*, which much more nearly resemble the species of Œdipus in the disposition of the vomerine teeth and cylindric form of the tail, this separation is much retarded.

These genera may be parallelized also in the following manner in illustration of the law of heterology:*

PLETHODONTÆ.		SPELERPES.
	A. One premaxillary.	
	No fontanelle.	
Stereochilus.		
	A fontanelle.	
	Toes 4–5.	
	Teeth large.	
Autodax.		
	Teeth small.	
		Spelerpes.
	Toes 4–4.	
Batrachoseps.		*Manculus.*
	AA. Two premaxillaries.	
	Toes free.	
Hemidactylium.		
Plethodon.		*Gyrinophilus.*
	Toes united.	
		Geotriton.

The minor relations may be more readily expressed thus:

PLETHODONTÆ.		SPELERPES.
	Digits 4–5.	
	α. Digits distinct.	
Plethodon.	Two premaxillaries.	*Gyrinophilus.*
Autodax.	One premaxillary.	*Spelerpes.*
	α. Digits united.	
	Two premaxillaries.	*Geotriton.*
	One premaxillary.	*Œdipus.*
	Digits 4–4.	
Hemidactylium.		*Manculus.*
Batrachoseps.		

* See Origin of Genera, p. 53.

Or thus:

Two Premaxillaries.		One Premaxillary.
	Digits 4–5,	
	α. Distinct.	
	Tongue free.	
Gyrinophilus.		*Spelerpes.*
	Tongue attached.	
Plethodon.		*Stereochilus.*
	αα. United.	
Geotriton.		*Œdipus.*
	Digits 4–4.	
Hemidactylium.		*anculus.*
		Batrachoseps.

Some other characters found in this family are those of low development and approximations to the larval condition. Thus three of the species exhibit at times a subnareal cirrhus, which occurs in some of the Cœcilidæ, and Xenopus among Salientia. It is the persistence of that long subocular tentacle characteristic of the early larval stage of Urodela generally (see Plate 16), and of a later larval stage of Xenopus (*vid.* Wyman *and* Gray), where they resemble the appendages of the Siluridæ. They have been called crochets by Rusconi, and homologized with the cylindric cephalic processes of the larval Rana, with what correctness remains to be proven by observations on other types.

Eschscholtz correctly represents *Batrachoseps attenuatus* as without prefontals. An elongate process of the frontal occupies only part of its place, forming no suture with the maxillary. This is quite different from Demognathus, where the orbit is completed by the union of frontal and maxillary. In *Manculus quadridigitatus* the prefrontal occupies this depression as an elongate vertical scale.

In *Spelerpes ruber* the quadratum presents a small internal anterior ala, which has a superficial resemblance to a pterygoid. In this species there is apparently an azygus bone behind the premaxillaries. This is, however, only the exposed extremity of their united spines, which are nearly or quite isolated by the approximation of the anterior parts of the nasale. It does not occur in the *Gyrinophilus porphyriticus*.

BATRACHOSEPS Bonap.

Fauna Italica; Gray, Cat. Brit. Mus., 1850, 42; Cope, Proceed. Ac. Phila., 1869, p. 98; Stranch, Salam., p. 84; Boulenger, pt. Cat. Brit. Mus., ed. II, 1882, p. 52.

Tongue adherent anteriorly. Digits 4, 4; a large parietal fontanelle. Premaxillary single, pierced by a fontanelle.

This genus embraces the forms which may be considered the lowest in the family. It differs from Hemidactylium as Thorius does from Spelerpes, *i. e.*, in the nonossification of the parietal bones. This low grade of development is here seen in the extremities also, which are

much reduced, and the snake-like form of one of the species. The species are four, as follows:

I. Costal plicæ, eighteen; the toes well developed, palmate.
Outer posterior toe well developed; hind limb extending over 7.5 costal interspaces, fore limb to orbit; tail equal body and head to orbit, more slender than the body; belly yellowish ..... *B. pacificus.*

II. Costal plicæ, nineteen to twenty-one; toes very rudimental, little distinct.
a. Parasphenoid teeth in one patch.
Hind limb extending over six costal interspaces; fore limb nearly to orbit; tail as long as body and head to orbit; width of head seven times from muzzle to groin; belly black ..... *B. nigriventris.*
Hind limb extending over four costal interspaces; fore limb not to angle of mouth; tail thick as body, as long as body and head plus the length from muzzle to axilla; width of head eight times from muzzle to groin; belly brown ..... *B. attenuatus.*
aa. Parasphenoid teeth in two patches.
Hind limb extending over four costal spaces; tail more than twice as long as head and body; sides dark ..... *B. caudatus.*

BATRACHOSEPS CAUDATUS Cope.

(Plate LXXXI, fig. 2.)

Head short, wide, muzzle as long as eye, the nostril not quite terminal. Length from end of muzzle to humerus entering 3.33 times in length from humerus to axilla. These proportions are those of the *B. attenuatus.* Tail excessively elongate, 2.2 the length of the head and body. In the *B. attenuatus* the tail is 1.6 the length of the head and body and less (measurements made from femur). Limbs about as in *B. attenuatus*, the anterior reaching the first dermal groove behind the mouth, and the posterior covering four intercostal spaces when extended forwards. The inner digits are rudimental, that of the anterior foot possessing a metacarpus only. The costal grooves number twenty-one; they extend across the abdomen, but are not visible on the back. The tongue is a longitudinal oval. The vomerine teeth form two convergent brands directed inwards and posteriorly from within the choanæ. They are better developed than in *B. attenuatus.* The parasphenoid teeth are in two distinct patches, thus differing from those of the *B. attenuatus*, where they form a single patch.

Measurements.

	M.
Total length	.160
Length to axilla	.0115
Length to groin	.051
Length to base of tail	.057
Width of head	.006
Length of fore limb	.0065
Length of hind limb	.007

The general color is brown. It is deeper on the sides to a line on each side of the back and on the anterior half of the abdomen and on the superior surface of the distal part of the tail. Gular region and chin yellowish.

This is the most vermiform North American salamander, resembling the *Œdipina uniformis* Keferst. of Central America in its proportions. Its relations to the *Batrachoseps attenuatus* are close, but its differences may be summarized as follows: (1) The two patches of parasphenoid teeth; (2) the absence of dorsal grooves; (3) the very elongate tail; (4) the longer patches of vomerine teeth. The habitat of the *B. caudatus* is much north of any from which the *B. attenuatus* has been obtained.

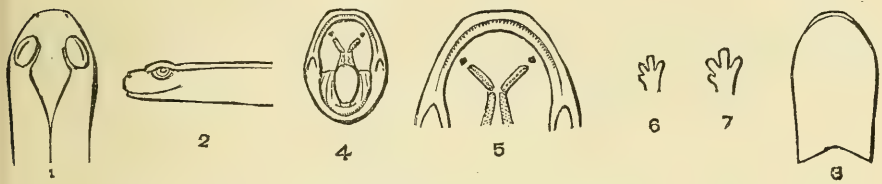

Fig. 27. *Batrachoseps caudatus*, No. 13561. Hassler's Harbor, Alaska; $\frac{2}{1}$ except Fig. 5=$\frac{4}{1}$.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
13561	1	Hassler Harbor, Alaska	.....	Henry E. Nichols	Alcoholic.

BATRACHOSEPS ATTENUATUS Esch.

Bonap., Faun. Ital.; Hallow., Journ. Ac., Phila., IV, 1858, p. 348; Cope, Proceed. Ac. Phila., 1869, p. 98; Strauch, Salam., p. 85; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 42; Boulenger, Cat. Batr. Grad. Brit Mus., ed. II, 1882, p. 60.

Salamandrina attenuata, Eschsch., Zool. Atlas, p. 1, Pl. 21, fig. 1–14.

This species is well characterized by its slender form and its very weak extremities. The costal folds are nineteen, more rarely twenty or eighteen, and are well marked on the back and belly, and turned forwards toward the median line on the former, which is marked by a delicate groove. There are four lateral folds in front of the fore limb, three of which are crossed by a longitudinal fold from the orbit. The tail is longer than in any other North American salamander, except the *B. caudatus*, and is entirely cylindrical, and undistinguishable at the origin from the body; it is marked by forty-seven distinct annuli to the end of the vent. The toes are very small and obtuse, and free for the length of only one phalange; below this a web connects them. The inner toe on both feet is a mere knob. The extended fore limb reaches the transverse fold behind the canthus oris; and the extended hind limb covers four intercostal spaces.

The head is short, broad, and flat, and the muzzle is as long as the diameter of the orbit. The lip is more or less prominent below and before the orbits. The palatine teeth do not extend to behind the nares; they form two very oblique short series, which nearly meet posteriorly

on the median line, and are well separated from the sphenoidal patches. The latter are not separate, and form one wide oval brush.

Measurements of No. 11801.

	M.
Total length	.111
Total length of head and body	.047
Total length from muzzle to groin	.044
Total length from muzzle to axilla	.011
Total length from muzzle to canthus oris	.004
Length of fore limb	.006
Length of hind limb	.007
Length of hind foot	.002
Width of head	.005

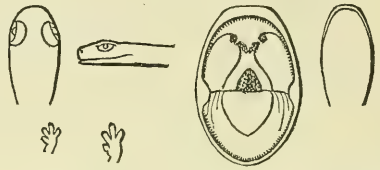

FIG. 28. *Batrachoseps attenuatus.* 13895, $\frac{3}{2}$; fig. 5 = $\frac{3}{1}$.

The color of the lower surface is brown, with a few whitish points on the gular region and tail, and frequently over the whole abdomen. The sides are darker, sometimes almost black. The upper surface is generally a paler brown, with a light shade extending on each side from the nape to the base of the tail. These bands are composed of numerous short longitudinal streaks, which become separated on the base of the tail, and cover its surface to the end, or to the middle, as the case may be. This light color has generally a reddish hue, and in many specimens extend entirely across the dorsal region, forming a band, not unlike that of *Plethodon cinereus erythronotus.*

Habitat.—This is an abundant species of the Pacific coast region of the continent, but it has not been found to the eastward of the Coast Range of mountains. I have examined eight specimens from near San Francisco, in the Museum of the Philadelphia Academy, from William M. Gabb, and one in the Museum of the Essex Institute from the same locality, obtained by Mr. Samuels, and the following:

Batrachoseps attenuatus Esch.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
6890	1	California		Dr. Wm Stimpson	Alcoholic.
11801	10	Fresno, Cal	1879	Gustave Eisen	Do.
4009	2	California			Do.
8001	6	Monterey, Cal		Canfield	Do.
4017	14	Petaluma, Cal		E. Samuels	Do.
4043	2	California		C. C. Boyle	Do.
13963	4	Sierra Nevada Mountains, Cal	July, 1884	R. E. C. Stearns	Do.
14454	7	Ballenas Bay, Cal		K. Hemphill	Do.

BATRACHOSEPS NIGRIVENTRIS Cope.

Proceed. Ac. Phila., 1869, p. 98; Boulenger, Cat. Brit. Mus., ed. II, 1882, p. 60.

This small species resembles the next in general proportions, but is nearer the last in the rudimental condition of the limbs.

Muzzle shorter than orbit; upper lip slightly angulated; a groove from the orbit posteriorly; a gular fold. Costal grooves extending to vertebral line, but not curved forwards there, as in *Hemidactylium scutatum;* extending across abdomen. Body slightly compressed. The tail as stout as the body at the base, subquadrate in section, becoming compressed at the tip; strongly annulate; not swollen. Inner digits on both feet minute. Vomerine series well developed; parasphenoidals as in the last.

Measurements, in inches.

	Lines.
Total length	22
Total length exclusive of tail from vent	13.5
Muzzle to axilla	3.5
Width of head	1.7
Length of fore limb	1.8
Length of hind limb	2

Color above deep brown, separated abruptly from the black of the lower surfaces; tail black.

Two specimens of this species were brought to the Museum of the Academy of Natural Sciences of Philadelphia from Fort Tejon, Cal. The only other specimen known to me is the following:

Batrachoseps nigriventris Cope.

Catalogue number.	No. of spec.	Age.	Locality.	When collected.	From whom received.	Nature of specimen.
13963½	1	Young	Sierra Nevada Mountains, Cal.		R. E. C. Stearns	Alcoholic.

BATRACHOSEPS PACIFICUS Cope.

Batrachoseps pacificus Cope, Proc. Ac. Phila., 1869, p. 98; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 59.

Hemidactylium pacificum Cope, Proc. Ac. Nat. Sci., Phila., 1865, p. 195.

The general proportions of this salamander are not unlike those of *Hemidactylium scutatum* Tsch. It differs from this in its uniform color above and below, and in some more important points. Upper surfaces dark brown, lower brownish-yellow. Vertebræ and costal folds between axilla and groin eighteen, the latter not prolonged dorsally, as in the *H. scutatum.* Head oval, elongate; lip rounded; eyes large, prominent longitudinal diameter longer than length of muzzle. Muzzle to humerus half length from latter to groin. Tongue elongate, oval; parasphenoid teeth approaching near to the short oblique series of vomer-

ines. Fore limb to orbit, hind limb scarcely longer, reaching the eighth fold from behind. The inner digit on both extremities is so short as to render the members almost 3–3. Tail elongate, slender, subcylindrical. Gular fold represented by a line.

Measurements, in inches.

	Lines.
Length of head to angle of mouth	2.5
Breadth of head behind eyes	2
From muzzle to humerus	5
From muzzle to groin	16.5
Length of tail	17
Length of posterior limb	3.5

Batrachoseps pacificus Cope.

RESERVE SERIES.

Catalogue number.	No of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
6733	1	Santa Barbara, Cal		Dr. Hays	Alc. type.
4006	2	San Francisco, Cal		R. D. Cutts	Alcoholic.
	3				

HEMIDACTYLIUM Tschudi.

Classif. der Batrachier, Trans. Neuchatel, 1838, p. 54–94; Bonap., Fauna Ital., II, 131, Nro. 10; Fitzinger, Syst. Rept., 33; Baird, Journ. Ac. Nat. Sci. Phila., I, 284, 1849; Hallowell, *l. c.*, 1858, 365; Gray, Cat. Brit. Mus., 1850, 41; Cope, Proceed. Acad. Phila., 1869, p. 99.

Desmodactylus, Dum. & Bibr., Erp. Gen., IX, p. 117.

Tongue adherent anteriorly; digits 4–4; parietal bones fully ossified, without fontanelle; two premaxillaries, with fontanelle; prefrontal bone present.

This genus is only distinguished from Plethodon by the deficiency of its hind foot in digits. Those that remain are quite rudimental. It differs from Batrachoseps in the presence of the prefrontal bone. There is but one species known, and its habits are entirely terrestrial.

HEMIDACTYLIUM SCUTATUM Tschudi.

Batr., p. 94; Hallow., Journ. Ac. Phila. (2), III, p. 366; Strauch, Salam., p. 76; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 41.

Salamandra scutata, Schleg., Faun. Japon., Amph., p. 119, and Abbild., Pl. 40, figs. 4–6.
Salamandra melanosticta, Gibbes, Bost. Journ. Nat. Hist., V, p. 89, Pl. 10.
Desmodactylus scutatus, Dum. & Bibr., p. 118.
Desmodactylus melanostictus, Dum. & Bibr., p. 119.
Batrachoseps scutatus, Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 59.

Whole skin finely and beautifully granulated; viewed vertically, the sides of head are parallel, the eyes forming the anterior corners, and not projecting beyond the line of head; muzzle not tapering, but sides nearly parallel, almost entirely truncate, and overhanging lower jaw; eyes nearer muzzle than *Plethodon erythronotus* (viewed from above); outline contracted behind the occiput, then expanding to middle of body

and tapering to anus; expanding again towards middle of tail, then contracting to an elongated point. Thus there is a decided contraction at base of tail not seen in most other species. Tail oval in its section throughout, though only exhibiting a ridge on posterior half.

The back and sides curiously sculptured by furrows, disposed as follows: At origin of hind legs begins a dorsal furrow, which continues to middle of vertex, when it bifurcates, sending a branch to each eye. There are fourteen vertical furrows (costal) on sides, which are more generally indicated across abdomen. A rather obsolete longitudinal furrow on each side marks the upper boundary of these vertical furrows and the outline of back. From the dorsal line proceed backwards, at an acute angle, furrows corresponding in number, and uniting with lines directed at a less acute angle from the superior ends of costal furrows. The lateral longitudinal furrows mark the origin of the latter lines. The sides of head also sculptured externally to the bifurcations and roughened between eyes. One or two furrows or constrictions go entirely around the tail behind the vent, marking the narrowed base of the tail, which then swells abruptly in many specimens.

Feet very weak; toes very little developed, only four on hind foot, of which one is nearly obsolete. External and internal toes of fore-feet very small. Eyes not very large nor prominent. Pupil large, black. Iris above, golden bronze; beneath darker. A general resemblance to *Plethodon cinereus* in color. Back, dark chestnut, but above much lighter, both sprinkled with black, the latter more especially along the dorsal line. Snout above, eyes above, and in certain lights the furrows above the lateral longitudinal lines, light chestnut, approaching to golden bronze, faintly clouded in spots with darker; side of body finely mottled brown and bluish-white. Head, body, and tail below chalk white, with a tinge of blue, sparingly and irregularly marked with rather large black spots; spots disposed along sides and the white of tail beneath. Central tract unspotted.

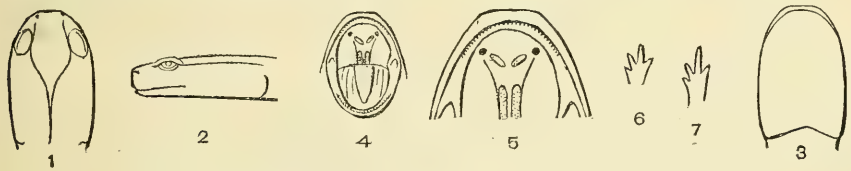

FIG. 29. *Hemidactylium scutatum*, No. 4094. W. Northfield, Ill.; 2/1.

Measurements of No. 4091.

	Lines.
Total length	40 2
Length to end of vent	17.8
Length to groin	15.6
Length to axilla	3.3
Length to canthus oris	2
Length of fore limb	3.2
Length of hind limb	3.75
Length of hind foot	1.1
Width of head	2.6

Besides specimens from Chester County, Pa., from Huntingdon County, Pa., and from Chicago, Ill., in the Museum of the Philadelphia Academy of Natural Sciences, the following are in the National Museum. Professor Verrill says it is abundant near New Haven, and the Essex Institute possesses it from Gloucester and Beverly, Mass. Dr. J. E. Gray, Catalogue of British Museum, gives Niagara. Dr. R. W. Gibbes described it from Abbeville, S. C.

Hemidactylium scutatum Tsch.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4083	1	Carlisle, Pa		Prof. S. F. Baird	Alcoholic.
4088	5	do		do	Do.
4730	1	St. Catherine's, Canada		Dr. D. W. Beadle	Do.
4093	1	Ripley, Ohio		P. R. Hoy	Do.
4094	9	Northfield, Ill.		R. Kennicott	Do.
4089	4	Meadville, Pa		Williams	Do.
4090	3	Riceborough, Ga		(?)	Do.
3743	1	Anderson, S. C		Mrs. Daniel	Do.
14459	1	(?)		(?)	Do.
4091	1	Washington, D. C		(?)	Do.
4724	1	Georgia		Dr. J. Jones	Do.

PLETHODON Tschudi.

System d. Batrachier, Trans. Neuchatel, 1838, 59–92; Bonap., Fauna Ital., II, 131. Baird, Journ. Ac. Nat. Sci., Phila., I, 292; Hallowell, *ib.*, 1858, 342; Cope, Proc. Ac. Nat. Sci., Phila., 1869, 124; Boulenger, Cat. Batr. Grad. Brit. Mus., II ed., 1882, p. 53.

Heredia Girard, Proceed. Acad., Phila., 1856, p. 735.

Tongue attached by the median line below, from the glosshyal bone to near the anterior margin; vomerine and parasphenoid teeth present; a large fontanelle between the spines of the separate premaxillary bones. Toes 4–5, normal. Anterior teeth not enlarged. Cranium well ossified. Prefrontal bone present.

This genus is highly characteristic of the *Regio nearctica*, where five species represent it on the Pacific slope and three in the eastern district. A species from Japan, named *P. persimilis* by Gray, is shown by Mivart not to belong to this genus. The species are all terrestrial in their habits, and three which I have observed (*P. oregonensis*, *P. glutinosus*, *P. cinereus*) undergo their metamorphosis while quite small. The last named, and probably *P. glutinosus*, never enter the water, but are hatched in damp places on land. The branchiæ have therefore no functional service. The species are as follows:

α. The parasphenoid patches in contact throughout; vomerine series well separated medially.

β. The tail cylindric.

Costal plicæ 16 to 19; form slender; tail cylindric; limbs weak; inner toes rudimental; vomerine series not extending beyond nares externally; belly brown-marbled; above plumbeous, or with a red longitudinal band. *P. cinereus.*

Costal plicæ 14; form stout; tail rounded; limbs short, stout; inner digits distinct; vomerine series extending outside of inner nares; black, usually with gray lateral blotches and smaller dorsal spots..... *P. glutinosus.*

Costal plicæ 13; form as in *P. glutinosus;* tail longer than head and body; digits truncate, the internal ones very rudimental; vomerine series very oblique, not extending behind choanæ; black, with yellow spots, which are largest on the head, large on the back, and minute on the sides. *P. æneus.*

"Costal plicæ 13; form moderate, tail cylindric, shorter than head and body; vomerine series very oblique, not extending externally to choanæ; toes more acute; black, with large yellowish spots; smaller on back, wanting on head" ..... *P. flavipunctatus.*

$\beta\beta$. The tail compressed.

Costal plicæ 15; form slender; tail well compressed; limbs weak; inner toes rudimental; vomerine series not extending outside of nares; belly brown-marbled; above, with a red dorsal band..... *P. intermedius.*

Costal plicæ 14; form stout; head large; limbs robust; inner toes distinct; tail compressed from the base, shorter than length of head and body; uniform dark brown above, and lighter brown below..... *P. crassulus.*

$\alpha\alpha$. Parasphenoid patches well separated.

β. Tail rounded.

Costal plicæ 13; form stout; head large, wide; lower jaw wider than upper; muzzle broadly truncate; vomerine teeth approximated medially; tail slender, subcylindric; black, limbs, belly, and spots of back, orange. ..... *P. croceater.*

Costal plicæ 10–11; form stout; head wide; maxillaries wider than mandible; muzzle narrowly truncate; vomerine teeth approximated medially; tail slender, subcylindrical; light brown above; limbs and below yellow. ..... *P. oregonensis.*

PLETHODON CINEREUS Green.*

Salamandra cinerea, Green, Journ. Acad., Phila., I, p. 356.

Plethodon cinereus, Tschudi, Batr., p. 92; Cope, Check List N. Amer. Batr. Rept., 1875, p. 27.

Salamandra erythronota, Green, Journ. Ac. Phila., I, p. 356; Holbr., N. A. Herp., V, p. 43, Pl. 11; De Kay, N. Y. Faun., Rept., p. 75, Pl. 16, fig. 38; Wied., Nova Acta Leop.—Carol., XXXII, p. 126.

Plethodon erythronotus, Baird, Journ. Ac. Phila. (2), I, p. 285; Dum. & Bibr., IX, p. 86; Cope, Proc. Ac. Phila., 1869, p. 100; Strauch, Salam., p. 72; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 57.

Amblystoma erythronotum, Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 37.

Salamandra agilis, Sager, Peninsular Journal of Medicine, 1858, p. 429.

This species is among the most elongated and slender of American salamanders. It is almost perfectly cylindrical throughout; a very slight amount of compression only being visible towards the end of the conical tail, which is longer than the head and body. It is much

* Plate 19, figs. 4–6.

slenderer and more vermiform, with much weaker legs than *P. glutinosus*. Thus in specimens of the two, measuring 1.80 from snout to groin, the head and body of *P. glutinosus* have the width one-third greater.

There are eighteen well-marked costal furrows between the limbs, excluding any in the axilla. The posterior are situated in the groin, bifurcating above. In a single specimen of var. Cinereus (No. 3805) we reach a count of nineteen. This increase in the number of costal furrows is coincident with the wide separation of the limbs, the distance from head to axilla being contained about $3\frac{1}{3}$ times in that to the groin, instead of $2\frac{1}{2}$, as in *P. glutinosus*. The tail is longer than head and body; sometimes considerably more so.

This species, including all varieties, has an extensive range, being found throughout the United States east of the Mississippi River. It appears to be more abundant in the Middle States; its northern range is to the middle of Maine, Ontario, and Michigan.

Its habits are entirely terrestrial, as it is never, even in the larval stage, found in the water. It is abundant under stones and logs in the forests everywhere, and does not occur in open fields. The eggs are laid in a little package beneath a stone in a damp place. When the young emerge they are provided with branchiæ, but these soon vanish, and they are often found in this young stage apparently quite developed.

Plethodon cinereus cinereus Green.

The color of the upper half of body and tail is a dark liver-brown; beneath dirty whitish, finely vermiculated or mottled with brown in about equal proportions, giving rise to a "pepper and salt" appearance. There is sometimes a yellowish tinge towards the head, and a plumbeous under the tail. On the sides the appearance is more that of whitish specks in a dark ground. Sometimes the upper parts are clear brown, at others more or less varied with very minute spots of dull grayish-white. Sometimes the under parts are so much clouded with brown as to appear principally of this color, only faintly mottled with lighter (3805.)

This species is easily distinguished from *P. glutinosus* by much slenderer form, smaller limbs, more webbed digits, eighteen costal grooves stead of fourteen, vermiculated under parts, which have not the black inground, the absence of the appearance of pieces of lead foil on the sides, etc. The limbs are very small and weak. The digits are distinct, though short. The basal web extends rather farther forward than in *P. glutinosus*, the two terminal joints of the longest toes only being free, instead of two and a half.

I can detect nothing in the characters of head and tongue different from *P. glutinosus*.

Measurements, in inches.

Length, measured along axis of body:
- From snout to gape ..... .15
- From snout to gular fold ..... .35
- From snout to armpit ..... .55
- Froms nout to groin 1.80
- From snout to behind anus 2.00
- From snout to end of tail 4.10
- Tail 2.10

Head:
- Width of head ..... .23
- Width of orbit ..... .09
- Distance between eyes anteriorly ..... .12
- Distance between outer nostrils .08

Body:
- Circumference of belly ..... .75
- Distance between armpit and groin 1.24

Tail:
- Height of tail where highest ..... .12

Limbs:
- Free portion of longest finger ..... .05
- From elbow to tip of longest finger ..... .21
- Free portion of longest toe ..... .07
- From knee to tip of longest toe ..... .25
- Distance between outstretched toes ..... .82

Plethodon cinereus cinereus Green.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4885	1	Mount Joy, Pa		J. Stauffer	Alcoholic.
4888	1	Brookville, Ind			Do.
5963	4	Hudson's Bay Territory.		C. Drexler	Do.
4729	2	St. Catherine's, Canada.		Dr. D. W. Beadle	Do.
3790	10	Carlisle, Pa		Prof. S. F. Baird	Do.
12610	1	Potomac River, D. C.	Apr. —, 1882	Edwin Prindle	Do.
3835	2	Carlisle, Pa		S. F. Baird	Do.
8573	1	Bainbridge, Pa	Dec. 8, 1875	J. F. Garrette	Do.
11449	35	(?)		(?)	Do.
12015	4	(?)		J. H. Richard	Do.
3818	13	Clark County, Va		C. B. R. Kennerly	Do.
3805	1	Columbus, Ohio		(?)	Do.
3807	1	Adirondack, N. Y		R. Clarke	Do.
3788	3	Racine, Wis		(?)	Do.
4720	4	Georgia		Dr. William Jones	Do.
13411	4	Boston, Mass		T. Rooseveldt	Do.
3825	1	Ripley, Ohio		P. R. Hoy	Do.
3787	1	Coxsackie, N. Y		Prof. S. F. Baird	Do.
3770	15	Detroit, Mich		C. Sager	Do.
13316	9	Fairfax County, Va		George Shoemaker	Do.
3818	1	Clark County, Va		C. B. R. Kennerly	Do.
11708	18	(?)		(?)	Do.
3867	1	Adirondack Mountains.		R. Clarke	Do.
4726	4	Philadelphia		J. H. Richard	Do.
3813	1	Hampshire County, Va		M. McDonald	Do.
3824	2	Tyree Springs, Tenn		Major R. Owen	Do.
4721	5	Georgia		Dr. W. C. Jones	Do.
4731	2	Detroit, Mich		Dr. A. Sager	Do.
4000	6	Southern Illinois		R. Kennicott	Do.

Plethodon cinereus erythronotus Green.

(3766, Clark County, Virginia.)

I have been unable to detect any difference in structure, proportions, and general character between this supposed species and *P. cinereus*. The only difference, if any there be, is to be found in the color of the back, that of the side and belly being very much the same. A broad, light-reddish stripe commences at the nape of the width of the interorbital space, and continues to the tip of the tail, on which it diminishes gradually in width. The central region of this stripe generally

exhibits a very fine mottling of brownish, scarcely obscuring the effect of the red ground. The mottling is sometimes equally distributed—sometimes concentrated in some places more than others. The sides of the body are abruptly and continuously dark brown, but soon fades off below into the pepper and salt of the lower sides and belly. There is sometimes the effect of a broad dark stripe on each side the red, but this is usually very illy defined below.

The color of the red stripe varies considerably. Sometimes it has a shade of pink—sometimes of orange or yellowish. The close resem-

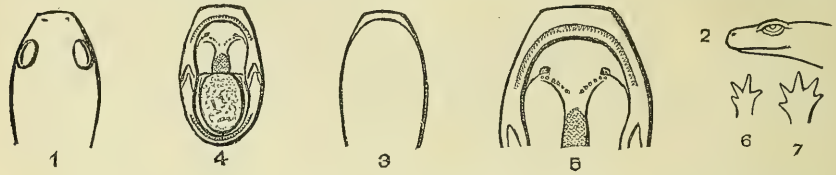

FIG. 30. *Plethodon cinereus erythronotus*, 4826. St. Catharines, Canada; ⅔.

blance in size and character with the frequent association in the same localities between the two species have given rise to the belief that they were different sexes of the same species. That this supposition is incorrect is proved by the fact that both males and females are found of each kind, as was long ago noticed by Haldeman. As varieties they are very permanent ones, as I have found all the young of the same brood or set of eggs, whether in the eggs or just escaped from them, uniformly with either dark backs or red ones. I have found adult red-backed specimens watching eggs with red-backed embryos, and brown-backed in charge of brown-backed embryos. There is also some difference in geographical distribution. Thus, on the west side of Lake Champlain, in Essex County, New York, Professor Baird states that he has found the red-backed salamander very common, and never saw there the *P. cinereus.* Among a very great number of specimens which I have examined in the collections of the Smithsonian Institution, the Academy of Natural Sciences, and Essex Institute I have observed but four specimens of the red-banded variety and four of the gray which could be regarded as intermediate in character. This appears in a rufous cast in the dorsal color of the latter and a slight obliteration of the borders of the dorsal band in the former. Such coloration is, however, very uncommon in the living animal, which is everywhere exceedingly abundant. The statement made by J. A. Allen that such are abundant in Massachusetts is not confirmed by the specimens in the museum of the Essex Institute, Massachusetts.

An examination of the types of Dr. Sager's *Salamandra agilis* (3770) shows them to belong to this subspecies. His variety with livid back, is the *Plethodon cinereus cinereus.*

Measurements, in inches.

Length, measured along axis of body:
- From snout to gape ..... .14
- From snout to gular fold ..... .33
- From snout to armpit ..... .48
- From snout to groin 1.60
- From snout to behind anus 1.82
- From snout to end of tail 3.52
- Tail 1.70

Head:
- Width of head ..... .20
- Length of orbit ..... .09
- Distance between eyes anteriorly ..... .12
- Distance between outer nostrils .....? (.07)

Body:
- Circumference of belly ..... .65
- Distance between armpit and groin 1.10

Limbs:
- From elbow to tip of longest finger ..... .20
- From knee to tip of longest toe. .25
- Distance between outstretched toes. ..... .76

Plethodon cinereus erythronotus Green.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4898	3	Washington, D. C		Dr. William Stimpson	Alcoholic.
4891	1	New York			Do.
5383	3	Fort William, Lake Superior.		R. Kennicott	Do.
5415	2	Lake Superior		do	Do.
5375	5	South of Highlands		C. Drexler	Do.
7148	7	Rock Creek, D. C		H. W. Elliott	Do.
7823	10	Washington, D. C		Dr. E. Coues, U. S. A	Do.
9300	2	Norfolk, Conn	Sept. 26, 1877	A. F. Wooster	Do.
9258	1	Wood's Holl, Mass	1871	U. S. Fish Commission	Do.
3766	7	Clark County, Va		Dr. C. B. R. Kennerly	Do.
3758	18	Westport, N. Y		Prof. S. F. Baird	Do.
4828	2	St. Catharine's, Canada		Dr. D. W. Beadle	Do.
4839	1	Brookville, Ind		Dr. R. Haymond	Do.
4829	3	St. Catharine's, Canada		Dr. D. W. Beadle	Do.
3788	4	Racine, Wis			Do.
4728	6	West Northfield, Ill		R. Kennicott	Do.
3768	2	Allegany County, N. Y		D. Stevens	Do.
12611	1	Potomac River, D. C	Apr. —, 1882	E. Prindle	Do.
	90				

GENERAL SERIES.

7823	36	Washington, D. C		J. W. Dagins	Alcoholic.
3751	5	Gloucester, Va		Rev. C. Mann	Do.
9994	3	Middletown, Conn		W. H. Barnes	Do.
13410	6	Boston, Mass		T. Rooseveldt	Do.
3783	1	Ripley, Ohio		Prof. Hoy	Do.
12702	3	Lookout Mountain, Tenn.		W. F. Foe	Do.
13570	5	Norfolk, Conn		(?)	Do.
13314	3	Washington, D. C		George Shoemaker	Do.
13586	2	Rawley, Va		Benjamin Miller	Do.
3764	29	Meadville, Pa		Williams	Do.
3765	1	Lancaster, Ohio		L. Lesquereux	Do.
3763	1	Mississippi		Dr. Shumard	Do.
14452	1	(?)		(?)	Do.
3772	10	Orange, N. Y		Dr. J. G. Cooper	Do.
3778	1	Oneida County, N. Y		H. Davis	Do.
3755	25	Carlisle, Pa		S. F. Baird	Do.
3816	1	Upper Darby, Pa		Mr Smelt	Do.
4727	5	Philadelphia, Pa		J. H. Richard	Do.
4720	5	Georgia		Dr. W. L. Jones	Do.
3770	3	Detroit, Mich		Dr. Sager	Do.

Plethodon cinereus dorsalis Baird.

Cope, Proc. Ac. Phila., 1869, p. 100 (name only).

This subspecies has the size and proportions of body and limbs as in *P. erythronotus*, but may be readily distinguished by the smaller number of costal furrows, shorter body, and different character of the dorsal stripe.

There are only sixteen costal furrows between the fore and hind legs, instead of eighteen, as in *P. erythronotus*. This indicates a shorter body, and accordingly we find that the distance from snout to armpit is contained only three times in that from snout to groin, instead of $3\frac{1}{3}$ or $3\frac{1}{2}$, as in the other.

I am unable to detect any difference in the mouth, tongue, teeth, or limbs.

In alcohol there is a broad yellowish-red dorsal stripe, which begins at the nape and extends to the end of the tail. On the back it is on an average as broad as the interorbital space of the head. The outlines, instead of being parallel or nearly so, are very irregular on the back, exhibiting four or five coarse dentations between shoulders and rump, which in some specimens are nearly opposite each other (causing the dorsal stripe to be twice as wide at some places than in others), or more or less alternating. On the tail the outlines are straight, converging slightly to the tip. The sides and beneath are dull brownish-yellow or whitish, finely mottled, or vermiculated with dark reddish-brown, which becomes more crowded to the dorsal stripe, and is sharply relieved against it.

There is a distinct light line from the upper eyelid, passing internally to the nostrils and meeting its fellow in an angle in the middle of the muzzle, then sending down a single line to the edge of the lip.

Measurements, in inches.

Length, measured along axis of body:	
From snout to gape	.11
From snout to gular fold	.34
From snout to armpit	.46
From snout to groin	1.36
From snout to behind anus	1.62
From snout to end of tail	2.94
Tail	1.32
Head:	
Width of head	.20
Width of tongue	.12
Length of tongue	.17
Length of orbit	.09
Distance between eyes anteriorly	.13
Head—Continued.	
Distance between outer nostrils	.08
Body:	
Circumference of belly	.60
Distance between armpit and groin	.86
Tail: Height of tail where highest.	.10
Limbs:	
Free portion of longest finger	.05
From elbow to tip of longest finger	.23
Free portion of longest toe	.06
From knee to tip of longest toe	.23
Distance between outstretched toes	.75

This subspecies is readily distinguished from *P. erythronotus* by the different relative position of the limbs and number of costal furrows already referred to. The very jagged or irregular outlines of the dorsal stripe, the light line on the nose, and the lighter and more reddish shade of the lateral and inferior mottling will at once distinguish it as far as color is concerned. The dusky shade of the sides is not continuous above, but shows distinctly minute mottling of lighter.

It is somewhat difficult to assign to this form a definite status. I should be disposed to regard it as a good species, but for the fact that out of a great number of specimens of the *P. erythronotus* var. *cinereus* I find a single individual (Sm. No. 3825) from Ohio which presents the proportions of the present species, and the same number (sixteen) of costal plicæ. For the present therefore I refer it as a subspecies. I have seen five specimens, which agree in every particular; one in the Museum of the Essex Institute in a bottle with the common varieties of the *P. erythronotus*, the *Spelerpes bilineatus*, and Desmognathus, all from Essex County, Mass., and four specimens in the Museum of the Smithsonian as follows:

Plethodon erythronotus dorsalis Baird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3776	4	Louisville, Ky			

Habits.—The *Plethodon cinereus* is the most abundant salamander in the northern and central eastern United States. It is of terrestrial habits, and is easily found under logs and their bark, stones, etc. It feeds, like other species, on insects and their larvæ, capturing them by applying to their surface its flat and projectile tongue and jerking them quickly into its mouth. It frequently climbs to the summit of low vegetation, from which it springs by a sudden straightening or curvature of the body, as the case may be, in the manner of a caterpillar.

PLETHODON GLUTINOSUS Green.*

Tschudi, Batr., p. 92; Cope, Proc. Ac. Phila., 1869, p. 100; Strauch, Salam., p. 70; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 56.

Salamandra glutinosa, Green, Journ. Ac. Phila., I, p. 357; Holbr., N. A. Herp., V, p. 39, Pl. 10; De Kay, N. Y. Faun. Rept., p. 81, Pl. 17, p. 42.
Salamandra variolata, Gilliams, Journ. Ac. Phila., I, p. 460.
Salamandra cylindracea, Harlan, Journ. Ac. Phila., V, p. 156.
Plethodon glutinosum, Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 39.
Triton porphyriticus, De Kay, N. Y. Faun., Rept., p. 83, Pl. 16, fig. 37.
Cylindrosoma glutinosum, Dum. & Bibr., IX, p. 80.

This species is of a stout form, the body depressed, the head, body, and tail continuous, with very slight constriction at the neck; the tail

* Plates 26; 31, fig. 6; 35, fig. 2; 40, fig. 4; 45, fig. 5; 48, fig. 14.

cylindrical, very slightly compressed towards the pointed conical tip, and longer than the body.

The skin is everywhere closely lined with short perpendicular glands for secreting a milky juice. These are largest on the upper surface of the tail and more scattered on the belly. The skin is also closely covered with shallow pits, visible only when the mucus is removed and through a lens. I have not observed any large pores in patches on the head.

The head is broad, the sides parallel to the eyes, then converging and distinctly truncated at the end. The eyes are large and prominent, separated anteriorly by one and one-half diameters of orbit; the distance to the nostrils and between them rather less than this amount. The nostrils are lateral near the end of the muzzle. The upper jaw overlaps the under considerably, especially anteriorly; where there is a slight protuberance downwards of the lip on each side, the muzzle giving a concave outline when viewed both from before and laterally. There is a slight groove down the side of the muzzle from the outer edge of the nostrils to the swollen part of the lip.

The gular fold is entirely adnate, without any overlapping.

There are fourteen well-marked costal furrows, including the inguinal and one close to the fore-legs. They are distinct on the sides, but interrupted on the back and belly; none are distinctly visible along the pelvic region and the tail. There is a shallow furrow along the back, but not the least sign of ridge or compression on the cylindro-quadrate tail, although this is rather higher than wide towards the end.

The limbs are moderately developed. The digits are short, broad, linear, cylindrical, depressed, and slightly swollen into knobs at the ends, where they expand very little, but without any appearance of a disk. There is a short, thickened membrane connecting the basal joints of the digits, leaving three phalanges free of the longer toes and two and one-half of the fingers. This membrane has the effect to cause the bases of the digits to stand out very free and separate from each other.

The second and third fingers are nearly equal, the latter rather longer; the third toe longest; the fourth sometimes not shorter. The first finger and toe are quite rudimentary, being a mere knob. The distance from snout to axilla is contained less than three times in that to groin.

The tongue is very large, in alcoholic specimens frequently protruding beyond the jaws all round. It is oval, longer than broad, fleshy, and highly papillose, thin towards the margins. It is very slightly emarginate behind, the notch bordered by a ridge on each side. It is pedicellate, free behind and on the sides, but affixed to it anteriorly; the point of adhesion visible externally, as a circular or lozenge-shaped whitish spot just behind the jaw-bone, and about as large as the orbit of the eye. The attachment is complete anterior to the pedicel, which again is free from its sheath only behind. The tongue is thus evertile and capable of being thrown outwards. There is no free space anterior to the pedicel.

The palatine teeth form a series on each side in the shape of a short arc, the convexity antero-interior. These do not meet internally, but are separated by a short interval, as they are from the two plates of parasphenoidal teeth, beginning a short distance behind them and extending backwards, meeting along the median line. The inner nostrils are rather small, placed anterior and interior to the commencement of the palatine teeth. Besides the broad, shallow, short channel proceeding from the outer end of these nostrils past the external extremity of the palatine teeth, there is a deeper and very narrow one passing along the upper edge of the broad channel and along the margin of the upper jaw to its posterior extremity.

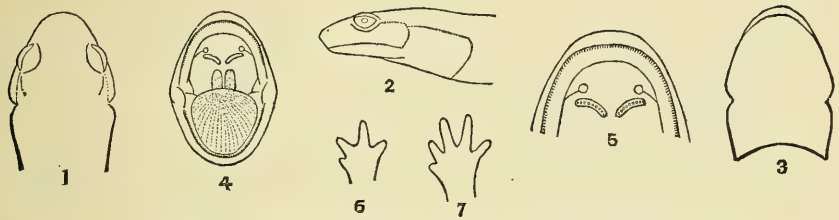

FIG. 31. *Plethodon glutinosus.* No. 3782. Abbeville, S. C.; ½.

This species in alcohol is of a livid bluish-black. The upper parts and sides are marked with well-defined specks of a grayish-silvery color, looking like torn pieces of foil. These vary with the specimen, but are generally more numerous and larger along the sides. The under parts are sometimes finely dotted with whitish, but this is usually the effect of the whitish glands seen through the integument. The under part of the tail is of a pale bluish-gray. The light spot on the chin, showing the attachment of the tongue, has already been referred to. The soles of the feet are also whitish.

The back is sometimes destitute of spots, or they are very minute, and these when present are often duller than those on the sides. There is occasionally a yellowish tinge in the lateral spots. A few spots of the same kind are sometimes found under the chin.

Young specimens are marked like the adult, except in being whitish beneath, and in frequently having the white spots more punctiform and scattered.

A number of young of eighteen lines in length from caves in Montgomery County, Va., have a series of small bright red spots on each side; some others from the same locality do not exhibit them. The variation is thus remotely similar to that in *Desmognathus fusca.*

I have not been able to discover any permanent difference between the southern specimens of this species and the northern. I have thought there was a greater tendency to expansion of the light spots on the side, so as even to form a continuous band, and to a reduction in size or disappearance of those on the back. I have, however, found

specimens of precisely similar character from northern localities. Some southern specimens appeared to have the digits less webbed than usual. In certain specimens from South Carolina described by Hallowell the white spots fail to exhibit themselves on the sides, the color being everywhere a deep black, the gular region, lips, palms, and soles being of a clear yellowish-brown. This constitutes a well-marked color variety, but no differences of a higher value can be found. There are four specimens of it in the Museum of the Philadelphia Academy.

The range of this species is from Texas to Maine. It is recorded by Packard as from Okok, Labrador (Mem. Boston Soc. Nat. Hist., 1868), but I suspect that this animal will be found to be the *Amblystoma jeffersonianum* var. *laterale*, which has, with the *A. j. platineum*, the highest northern range. It appears to be common in Massachusetts and Maine.

This salamander is entirely terrestrial in its habits. It is found much more abundantly in the mountainous districts, and haunts rocky localities as well as forest mold and fallen logs. I have found it more abundant in Pennsylvania and New York than in southwest Virginia. I believe that it prefers a cool climate; in the flat and warmer tertiary and cretaceous eastern coast region it is rare. In southern Pennsylvania I have only found it on the northern exposure of the south Chester Valley hill, never on the southern exposure or other part of the north hill. In southwest Virginia it is more common in caves than on the surface.

Measurements, in inches.

Length, measured along axis of body:	
From snout to gape	.31
From snout to gular fold	.66
From snout to armpit	.90
From snout to groin	2.50
From snout to behind anus	3.00
From snout to end of tail	5.90
Tail	2.90
Head:	
Width of head	.48
Width of tongue	.40
Length of orbit	.17
Distance between eyes anteriorly	.27
Distance between outer nostrils	.17
Distance between inner nostrils	.15
Body:	
Circumference of belly	1.60
Distance between armpit and groin	1.00
Tail:	
Height of tail where highest	.32
Breadth of tail where highest	.32
Limbs:	
Free portion of longest finger	.13
From elbow to tip of longest finger	.50
Free portion of longest toe	.16
From knee to tip of longest toe	.55
Distance between outstretched toes	1.85

Plethodon glutinosus Green.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8876	1	Mandeville, La	Nov.—, 1879.	N. O. Academy	Alcoholic.
3756	3	Georgia			Do.
5267	2	do		Dr. W. L Jones	Do.
3766	1	Tyree Springs, Tenn			Do.
3757	1	Dayton, Ala		A. E. Edgeworth	Do.
3762	2	Delaware County, Pa			Do.
7905	10	Carlisle, Pa		Prof. S. F. Baird	Do.
3773	6	Natchez, Miss		Col. B. C. L. Wailes	Do.
8024	10	Southern Illinois		R. Kennicott	Do.
9289	1	Moulton, Ala			Do.
5018	1	South Carolina			Do.
9288	1				Do.
3760	6	Tyree Springs, Tenn		Prof. R. Owen	Do.
3759	6	Meadville, Pa		Williams	Do.
9552	8				Do.
3784	3	Charleston, S. C			Do.
3782	5	Abbeville, S. C			Do.
3781	8	Riceborough, Ga			Do.
3754	8	Carlisle, Pa		Prof. S. F. Baird	Do.
4725	3	New Braunfels, Tex		Capt. S. Van Vliet, U. S. Army.	Do.
3779	2	Clarke County, Va		Dr. C. B. R. Kennerly	Do.
4891	1	New York		J. Stauffer	Do.
3789	3	Racine, Wis			Do.
6889	7	Charleston (?)			Do.
3775	2	West Northfield, Ill		R. Kennicott	Do.
11960	1	Milton, Fla		S. T. Walker	Do.
13315	1	Washington, D. C		George Shoemaker	Do.
3767	12	Orange, N. J		Dr. Cooper	Do.
	110				

GENERAL SERIES.

4889	1	Norfolk, Va			Alcoholic.
3785	2	Grahamville, S. C		Bailey	Do.
3781	3	Riceborough, Ga			Do.
3759	9	Meadville, Pa		Williams	Do.
9481	1	West Northfield, Ill		R. Kennicott	Do.
10904	3	North Carolina		Capt. William Holden	Do.
3761	12	Union County, Mo		P. R. Hoy	Do.
4814	1	Brookville, Ind		Dr. Haymond	Do.
4832	1	Brookville, Ind		Dr. R. Haymond	Do.
3763	2	Mississippi		Dr. Shumard	Do.
14453	2	Goose Creek, S. C		(?)	Do.
3777	1	Western Missouri		Dr. Shumard	Do.
14458	1	(?)		(?)	Do.
4722	4	Georgia		Dr. W. L. Jones	Do.
3774	4	Kemper County, Miss		D. C. Lloyd	Do.
5967	1	South Carolina		(?)	Do.
	4	Uniontown, Ala		E. R. Showalter	Do.

PLETHODON ÆNEUS Cope.

American Naturalist, 1881, p. 878.

Proportions as in *P. glutinosus*. Head oval, flat, its width entering length of head and body to thigh six times. Tail quite slender, cylindric from base, and longer than length of head and body by the width of the head. The limbs are well developed, and when appressed to the sides they overlap by the length of the distal phalanges.

The tongue does not fill the floor of the mouth, especially anteriorly The vomeropalatine teeth are in two straight series, which are directed posteriorly from the internal borders of the choanæ at an angle of 45

degrees. They are separated from each other on the median line by a short interspace and from the parasphenoids by a little longer one. This form is quite different from that characteristic of the *P. glutinosus*. There the series pass behind the choanæ, sometimes even beyond their external border, and from two arched series, not directed backwards in any such degree as seen in the *P. æneus*. The parasphenoid patches are close together, but a notch anteriorly and posteriorly indicates the extremities of the line of separation.

The internal digits on both feet are rudimental and terminate in a single small phalange, which does not extend beyond the extremity of the second metapodial bone, and is connected with the latter directly by the integument. The terminal phalanges of the other toes are truncate and slightly expanded at the tips, as in the *P. glutinosus*.

There are thirteen lateral dermal folds and a gular fold. The skin is smooth everywhere.

Measurements.

	M.
Total length	.118
Length of head and body	.0525
Length to groin	.047
Length to axilla	.0185
Length to rictus oris	.007
Length of fore-leg from axilla	.0158
Length of cubitus	.0053
Length of fore-foot	.006
Length of hind leg	.0175
Length of tibia	.0052
Length of hind foot	.0085
Width of head	.0083
Width between eyes	.0036

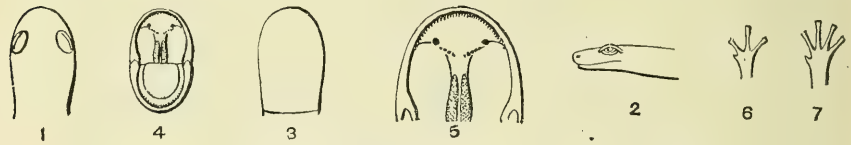

FIG. 32. *Plethodon æneus* Cope. S. Tennessee; ½.

The coloration is peculiar. Instead of the black color, with or without pale bluish dots, of the *P. glutinosus*, the sides and back are thickly spotted with large yellowish-green blotches of irregular form, producing an effect something like the coloration of the Mexican *Spelerpes leprosus*. The dorsal spots are much larger than the lateral, and are often confluent. On the head they almost exclude the ground color. The spots on the sides are quite small, as are those on the feet. The lower sides of the tail and belly are dusted with yellow, and the throat is also dusted, and a little more coarsely than the belly.

The characters which distinguish these species from the *P. glutinosus* are the different form of the vomeropalatine series of teeth, the absence of a costal dermal fold, and the coloration. There is some resemblance

to the *P. flavipunctatus* of Strauch, from California, to judge by the description given by that author. He states that the tail is shorter than the head and body, that the digits are more acute, and the spots are wanting on the head and smaller on the back than on the sides. In all these points it differs from the *P. æneus*.

I have seen but one specimen of this species. I took it at the mouth of the Nickajack Cave, which is in the mountains at the junction of the boundaries of the States of Georgia, Alabama, and Tennessee.

PLETHODON FLAVIPUNCTATUS Strauch.

Salam., p. 71; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 55.

Palatine teeth in two very oblique series, converging backwards, separated from each other by a slight interspace, not extending outwards beyond choanæ; parasphenoid teeth in two elongate patches in contact throughout, widely separated from the palatine teeth. Tongue very large; posterior border free. Head rather long, with a median longitudinal groove. Body cylindrical. Limbs as in *P. glutinosus*, but the fingers more slender and more pointed. Tail cylindrical, a little shorter than head and body. Skin smooth; thirteen costal grooves. Black, with large, irregular yellowish spots, more numerous on the sides and on the upper part of the tail, smaller on the throat and belly, absent on the upper surface of the head and the lower surface of the tail. Total length, 117^{mm}.

I have not seen this species, which is said by Dr. Strauch to have been obtained at New Albion, Cal. It must be rare or of local distribution. I have copied the above description from Boulenger's Catalogue of the British Museum, page 55.

PLETHODON INTERMEDIUS Baird.

Proceed. Ac. Nat. Sci. Phila., 1857, 209; Strauch, Salam., p. 72; Boulenger, Cat. Batr. Grad. Brit. Mus., 1882, p. 57.

This species, in general appearance, proportions of body, etc., is very similar to *P. cinereus erythronotus*, although abundant differences are easily discoverable. The body, as in that species, is slender and depressed, but the tail is slightly compressed at the middle, and more strongly at the extremity.

There are no apparent peculiarities about the head. The tongue is elongated, elliptical, without posterior emargination. There are fourteen costal furrows, or perhaps fifteen, if we include one above the axilla. The distance from snout to axilla is contained rather less than three times in that to groin.

The digits are well developed; more as in *P. glutinosus*. There is little, if any, indication of web at their bases, the three terminal phalanges of the third and fourth toes being free. The third and fourth toes are about equal. The outer toe is not more than half the second;

the first finger and toe are almost rudimentary. The third finger is decidedly longer than the second.

The dorsal surface of this species is traversed by a broad brownish-red stripe, extending from the nape to the end of the tail, the sides regular and nearly parallel, though more separated towards the middle of the back, where it is as wide as the interorbital space. The stripe is sparsely dotted with dusky spots throughout its extent. The sides are abruptly blackish-brown on each side the dorsal stripe; at first continuous, but becoming more and more interrupted by mottling. The belly is light brownish-yellow, thickly mottled with dark brown in about equal proportions; lightest under the chin. There is a dusky line from the eye to the point of the muzzle.

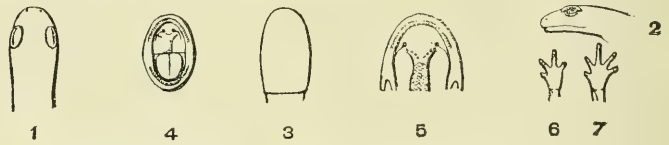

FIG. 33. *Plethodon intermedius*. No. 4732. Fort Tejon Cal.; ¼.

The general proportions and structure of this species are more those of *P. glutinosus* than of *P. cinereus*, although slenderer of body. In both there are about fourteen costal grooves. The outer digit in *P. intermedius* is nearly rudimentary, instead of prominent, as in the other species.

A distinguishing feature, when compared with *P. cinereus*, is found in the fourteen instead of eighteen costal grooves, the fore and hind limbs being thus less widely separated proportionally. The legs are stouter and the digits much less webbed (scarcely at all in fact). The third and fourth toes especially are much longer.

Independently of the structural peculiarities I find nothing in the color to distinguish this species from *P. cinereus erythronotus*.

Measurements, in inches.

Length, measured along axis of body:	
From snout to gape	.14
From snout to gular fold	.45
From snout to armpit	.65
From snout to groin	1.80
From snout to behind anus	2.15
From snout to end of tail	3.65
Tail	1.50
Head:	
Width of head	.25
Width of tongue	.15
Length of tongue	.24
Length of orbit	.09
Distance between eyes anteriorly	.15
Body:	
Circumference of belly	.80
Distance between armpit and groin	1.25
Tail:	
Height of tail where highest	.17
Breadth of tail where highest	16
Limbs:	
Free portion of longest finger	.07
From elbow to tip of longest finger	.31
Free portion of longest toe	.11
From knee to tip of longest toe	.37
Distance between outstretched toes	1.10

Plethodon intermedius, Baird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4732	1	Fort Tejon, Cal.	.....	J. Xantus	Type of description.
6635	1	Coal mines, Vancouver Island.	.....	Alden W. Hewson	

I have also this species from near Salem, in the Willamette Valley, Oregon, so that it probably occurs throughout the entire Pacific region.

PLETHODON CRASSULUS Cope.

Plate LXXXI, fig. 1.

Proceed. Amer. Philosoph. Soc., 1886, p. 521.

This species has a superficial resemblance to the *P. oregonensis*, but its manifold differences are easily perceived.

The form is quite robust, and the head is large, its width going into the length to the thighs only five times. The tail is very much compressed from the base, and is also shallow; its length equals the distance from its base to the gular fold. The legs are robust, but not very long; when appressed to the side they fail to meet by the length of the posterior foot.

The tongue is large, filling the floor of the mouth. The vomeropalatine teeth are in two short series, which converge backwards, without coming into contact, from behind the internal eye of the choanæ. The parasphenoid teeth are in a single undivided patch, which commences well behind the vomeropalatines. The maxillary and mandibular teeth are minute.

FIG. 34.—*Plethodon crassulus*. No. 9447. California; ½.

The head viewed from above is oval; in profile the muzzle is thick and truncate, and projects beyond the mouth. The edge of the lip is slightly angulate below the nares. The eye is rather large, its length equaling that of the muzzle. The distance between the nostrils is equa to that between the bases of the eyelids at their middles. The toes are short and free, one phalange of the first digit on each foot projecting. The ends of the toes are obtuse and bulbiform. A gular fold. Lateral folds fourteen.

Measurements of No. 9447.

	M.
Total length	.0625
Length of head and body	.034
Length to groin	.0314
Length to axilla	.0045
Length to line of rictus oris	.0065
Length to line of eye	.003
Length of fore-leg	.0095
Length of fore-foot	.0032
Length of hind leg	.0095
Length of hind foot	.004
Width of head	.0077
Width between eyes	.0025

Color above, uniform dark reddish-brown; below, uniform light brown.

I have seen but one specimen of this species, as follows: No. 9447; California; Dr. J. G. Cooper, collector.

PLETHODON OREGONENSIS Girard.

Cope, Proc. Ac. Phila., 1869, p. 100; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 54.

Ensatina eschscholtzii, Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 48 (*nec Triton ensatus*, Eschsch.).

Heredia oregonensis, Girard, Proc. Ac. Phila., 1856, p. 235, and U. S. Expl. Exped., Herp., Pl. I, fig. 18–25; Strauch, Salam., p. 76; Hallow., Proc. Ac. Phila, 1856, p. 235.

Plethodon ensatus, Cope, Proc. Ac. Phila., 1867, p. 167.

This species may be readily known by its relatively short and slender tail, its long, well-developed limbs, and wide head, as well as by its delicate coloration.

The form of the body is rather depressed, with distinct head and tail. The width of the head enters the length to the groin in the largest individuals 5.33 times; in those of medium size, 4.5 times; in the young of 17.5 lines in length it enters 3.5 times. Costal folds 11, the anterior indistinct or wanting, the posterior more than usually oblique, the inguinal extending forwards and upwards one space in advance of the origin of the femur. The limbs appressed overlap, so that the fingers reach the bases of the toes. There is no vertebral groove. The tail is slightly compressed, more distinctly so towards the extremity, and, what is exceptional and characteristic of this species and the *P. croceater*, most so inferiorly, leaving the upper outline flat for the proximal two-thirds the length. The postorbital fold is well marked and continues into the transverse fold of the throat. The head is oval, and without canthus rostralis; the muzzle rather thick, and with a subinferior truncation, which is not so marked as in *P. croceater*. The nostril is terminal and nearer the orbit than the diameter of the eye fissure. The latter enters the width between the anterior canthi of the same 1.33 times.

The inner nares are very small. The vomerine arcs curve backwards

medially, and nearly or quite in contact. The pterygoid patches commence at some distance behind these. They are of usual breadth, but diverge more posteriorly than in the species of the first section of the genus, resembling thus many species of Spelerpes. The teeth are very minute, and are arranged in series directed backwards and inwards. The tongue is a little more free than in *P. glutinosus*, as the lamina connecting the anterior and median points of support is quite thin.

The inner toe in both pair of limbs is quite small, but free and better developed than in *P. glutinosus*. In the anterior pair the third is the longest; the second is a little shorter than the latter, and the fourth a little longer than the first or inner one. The longest toe in the posterior limbs is the third likewise, the fourth being nearly equal to it, whilst the second is a little longer than the fourth, which itself is a little more developed than the first or innermost. Phalanges 1–2–3–2; 1–2–3–3–2.

The skin is perfectly smooth externally, but on being examined under the microscope it exhibits a mesh-work of little stellated mucous pores, similar to those of *Autodax lugubris*, but proportionally larger.

According to a sketch from life made by Mr. Drayton, of the United States Exploring Expedition, the ground color is milky white, with crowded dots of reddish-brown. On the specimens preserved in alcohol, however, the body, head, and limbs are of a uniform dark brown, lighter beneath. Under a low magnifying power minute dots may be observed scattered all over the surface. The color would appear to vary somewhat. A drawing in the Smithsonian records, colored from life by Samuels, represents the sides of head and body with lower surface of tail and anterior faces of limbs of a bright orange. This is the color of living specimens which I have taken myself.

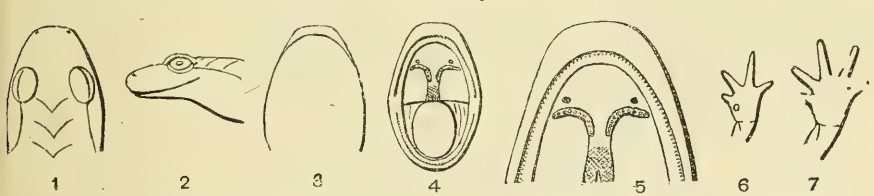

FIG. 35.—*Plethodon oregonensis*. No. 13946. Berkeley, Cal.; ½.

Measurements, in inches.

	In.	Lin.
Length from snout to gape		5
Length from snout to gular fold		9.3
Length from snout to axilla		12
Length from snout to groin	2	4
Length from snout to end of vent	2	9.2
Length from snout to end of tail	4	10.2
Length of fore limb		10
Length of fore-foot		3.5
Length of hind limb		10.5
Length of hind foot		4.5

	In. Lin.
Width of sole of hind foot	2.8
Width of tail	2.3
Width of body	5.6
Width of head (greatest)	5.6
Width between external nares	2
Width between internal nares	1.6

This handsome species would appear to be not uncommon in Oregon. I found it abundantly in the redwood forest at Russian River, California. Its eyes are prominent and beautiful in life.

Girard referred this species to a genus which he called Heredia, and as it appears to me without reason, as I can find no characters by which to distinguish it from Plethodon. Dr. Mivart informed me that this species was labeled as identical with the *Triton ensatus* Esch. in the British Museum, and presuming on the accuracy of the determination I called it *P. ensatus*. On examination of his figures I find that Eschscholtz's animal is very different, perhaps generically so, and probably worthy of reference to a genus Ensatina, in accordance with Dr. Gray's catalogue of the British Museum, a course followed by Dr. Boulenger.

Besides specimens in Museum of the Philadelphia Academy and Essex Institute, and my own cabinet, the following have come under my observation:

Plethodon oregonensis Gird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8000	1	Monterey, Cal		Canfield	Alcoholic.
4699	3	Puget Sound, Oregon		Dr. C. B. Kennerly	Do.
7022	1	do		C. B. R. Kennerly	Do.
4004	5	Petaluma, Cal		E. Samuels	Do.
13824	4	California	1884	J. S. Arnheim	Do.
13946½	2	Berkeley, Cal	1884	R. E. C. Stearns	Do.
6793	2	Puget Sound		W. Drayton	Do.

PLETHODON CROCEATER Cope.

Proceed. Ac. Nat. Sci. Phila., 1867, p. 210, *l. c.*, 1869, p. 100; Strauch, Salam. p. 70; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 55.

The largest species of the genus, and one of the most ornamented of the American salamanders.

In primary features this species is near the *P. oregonensis* Girard having the attachment of the tongue along the median line quite narrow, and a very narrow free margin in front. The palatine teeth form two long transverse separated arcs, which are directed more posteriorly at their median than exterior extremity, the latter extending farther outside the outer margin of the inner nares than the transverse diameter of the same. The tail is subcylindrical and slender; com-

pressed and narrowed in section below. No prominent glandular agglomerations or pores. Only three phalanges in the fourth toe.

Form of head peculiar. It is very broad, with straight converging maxillary outlines and truncate muzzle; upper surface much narrowed on muzzle; loreal regions plane, very oblique; canthus rostralis not marked. Maxillary outline obliquely spread at and behind orbits, where it is exceeded by the projecting margin of the mandible. Anteriorly, and at the end of the muzzle, it projects considerably beyond mandible. Muzzle truncate in profile; a slight emargination at middle of premaxillary border, and a groove on each side of it on inferior projecting face of lip. Nares terminal, some distance above the angulation of the lip, continued below in a groove, which bifurcates near lip margin; the posterior line extending a short distance, the anterior to the median emargination separating the anterior from the inferior plane of the muzzle. Eye large, not very prominent; its anterior canthus well in front of middle of jaw, and separated one diameter from nostril and 1.5 from the other eye.

No fold across from angle to angle of mandible, but the gular, parotoid, and postorbital grooves well marked. Costal grooves indistinct; 13. Skin everywhere very smooth.

Tail longer than head and body by the length of the mouth. Width at curves of mandible 4.6 times in length to groin. Extremities slender and long; when pressed to the sides the fingers extend to the heel. Length of whole fore limb 2.75 times in length to groin. Inner finger very small, half the length of the fourth; third longer than second. Sole narrow; longer than longest toes. Inner toe less than half the fifth; third a trifle longer than fourth; second much longer than fifth. Lower leg .75 thigh to groin.

Patches of parasphenoidal teeth, two in contact anteriorly, well separated from palatines. All the teeth minute, numerous, acute cylindro-conic. Tongue with rather straight lateral and posterior outlines.

Color throughout pitchy black, fading into bright red orange below; limbs orange, a blackish cross band below the knee. A large red-orange spot on each parotoid region, and four smaller, irregular, similar spots on the body to base of tail on each side of and near the vertebral line. A pair of orange spots at base of tail and a distant series on the upper face of the tail.

Besides the type, a specimen of this species was obtained at Cape St. Lucas, in Lower California, and I have seen one from near San Diego, at the northern end of that peninsula. As the typical specimen was found at Fort Tejon, Cal., the range of the species is extensive.

Measurements, in inches.

	In.	Lin.
Length:		
Measured along axis of body	5	11
From snout to gape (on front)		5
From snout to gular fold		8
From snout to armpit	1	.75
From snout to groin	2	5
From snout to center of anal slit		4.5
Head:		
Width of head		6.75
Width of tongue		3.75
Length of orbit		2.2
Distance between eyes anteriorly		3.3
Distance between outer nostrils		2.3
Head—Continued.		
Distance between inner nostrils		2
Tail:		
Height of tail where highest		3
Breadth		2.5
Limbs:		
Free portion of longest finger		2.25
From elbow to tip of longest finger		7.25
Free portion of longest toe		2.75
From knee to tip of longest toe		8.5
Distance between outstretched toes	2	4.4

No. 4701; one specimen; Fort Tejon, Cal.; John Xantus.

STEREOCHILUS Cope.

Character.—Tongue attached along the median line to the anterior margin; toes 4–5; premaxillary bones confluent, with a simple spine, without fontanelle.

This genus is represented by but one species of the austroriparian district of the nearctic region. It is evidently of aquatic habits, and is of larva-like proportions and appearance, but has the cranium fully developed and in some respects more solidly than its allies. In the only skeleton I have examined the prefrontal is present on one side and wanting on the other. The premaxillary bone is like that of Desmognathus, while the tongue is slightly freer than in Plethodon. The species exhibits weak extremities. It is from southeast Georgia, and is quite rare.

Costal plicæ, 17; elongate, head narrow, width more than seven times to groin, more than twice to axilla; no canthus rostralis; tail compressed from base, finned; small; pale yellow, brown lined ..... *S. marginatus.*

STEREOCHILUS MARGINATUS Hallowell.

Pseudotriton marginatus Hallow., Proceed. Ac. Nat. Sci. Phila., 1856, p. 130.
Spelerpes marginatus Strauch, Salam., p. 83; Boulenger, Cat. Batr. Grad. Brit. Mus. ed. II, 1882, p. 64.

This is a well-marked and peculiar species, and not nearly allied to any other. The head is more than usually elongate, with projecting, flat, truncate muzzle. The general dimensions of the head are small; the interorbital space is narrow and nearly plane, its width between the anterior canthi of the orbits not quite 1.5 the longitudinal diameter of the

eye. Both upper and lower palpebræ are transparent, a feature peculiar to this species.

The pores of the skin are large and on all the upper surfaces closely placed; on the sides more distantly. The mucous pores on the head are distinct and large. They form a double series along the canthus rostralis, and a single one above the orbit, which turns round the latter behind, and is continued below it and along the side of the muzzle to the nostril. A series of similar large pores extends along the middle of each side, one a little in front of the median point of the intercostal spaces. The tail is compressed from the base, and not elevated; it carries a strong free dermal border along the median line above on the distal two-thirds; a narrower dermal margin exists on the inferior distal half. The limbs are short and weak, but the digits are well developed. The posterior extended forwards measures 4.5 intercostal intervals; the anterior measures backwards 4½ of the same, counting the axillar. The phalanges number on the posterior feet 1–2–3–3–2; on the anterior, 1–2–3–2; the terminals are quite acuminate, especially behind, where in one individual they have a slightly corneous sheath. There are 17 costal folds and an axillar space. The tail is not annulate.

The rictus of the mouth measures nearly the diameter of the eye behind it. The tongue is small and free all round, except at the anterior margin and along the median line to the glossohyal pedicel. The vomerine teeth extend behind the nares in two series, which are convex posteriorly; they approach each other as though at an angle directed anteriorly, and then suddenly curve backwards and form the pterygoid series. These are more slender and more nearly approximated than in any other species, and consist each of but one row of teeth to the point where they begin to diverge; *i. e.*, near the posterior part of the globe of the eye. They do not diverge widely and exhibit but a few series of teeth.

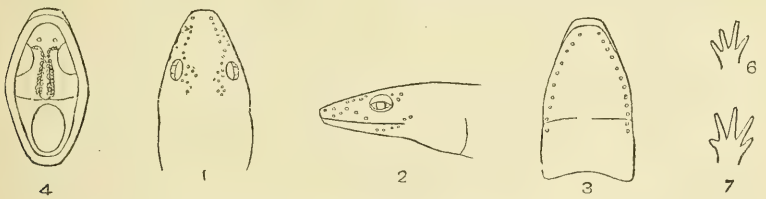

FIG. 36. *Stereochilus marginatus*. No. 3907. Georgia; ⅔.

The color is a delicate yellowish-brown, with numerous brown lines interspersed, which form several dark bands along the side. A narrow dark line extends from the orbit to near the axilla. A narrow yellow line, brown-bordered above and below, extends from axilla to groin. The tail, belly, and gular region are closely brown-specked; similar specks occur on the sides of the head behind. The ground color of the belly is yellow.

Axial measurements.

	M.
From muzzle to anterior canthus eye	.002
From muzzle to rictus oris	.0044
From muzzle to axilla	.012
From muzzle to groin	.0412
From muzzle to posterior margin vent	.0446
From muzzle to end of tail	.0795
Length fore limb	.006
Length fore-foot	.0025
Length hind limb	.008
Length hind foot	.004
Width between external nares	.001
Width between internal nares	.001
Width between canthus oris	.004
Width between humeri at axilla	.0027
Width between femora at groin	.0035

This peculiar salamander is probably aquatic in its habits. This is indicated by the compressed fin-like tail and the transparent palpebræ. It is quite elegant in its coloration. Nothing is known of its habits, as it is as yet very rare in collections. Besides the type specimen of Hallowell in the Museum of the Academy Natural Sciences, I have only seen the following:

No. 3907; two specimens; Georgia; Dr. Joseph Jones.

GYRINOPHILUS Cope.

Proceed. Acad. Phila., 1869, p. 108.

Tongue supported only by the glossohyal pedicel, boletoid; cranium fully ossified, the premaxillary bones remaining distinct and embracing a fontanelle. Digits entirely distinct, 4–5.

This genus is distinguished from Spelerpes on account of the marked peculiarity of the premaxillary bone, in which it resembles Plethodon rather than the first named. But one species is as yet known. It has a superficial resemblance to the *Spelerpes ruber*, but differs in several osteological peculiarities. Its nasal bones are well separated, and the proötic-squamosal crests are peculiar. The anterior or proötic crest is short, distinct, and curved inwards and backwards; that on the proximal extremity of the squamosal curves towards it, but leaves a considerable interspace. This is occupied by two osseous processes, like two teeth of a comb. In *S. ruber* the anterior crest only is present, and forms a rectangle, the anterior limb being transverse and the angle inwards. The nasal bones also are in contact across the premaxillary spines.

The type of the genus remains for a more than usually long period in the larval condition, and just before its metamorphosis is generally identical in its osteological characters with the genus Necturus, except in the absence of the intercalary bone, and the number of posterior digits.

Costal plicæ 16. Head wide, width less than seven times to groin, not over twice to axilla; a strong canthus rostralis; tail rounded at the base, not finned; large; uniform purple-gray above..... *G. porphyriticus.*

GYRINOPHILUS PORPHYRITICUS Green.*

Cope, Proceed., Ac. Phila., 1869, p. 108.

Salamandra porphyritica, Green, Contr. Maclur. Lyc., I, 1827, p. 3, Pl. 1, fig. 2.
Salamandra salmonea (Storer), Holbr., N. A. Herp., V, p. 33, Pl. 8; De Kay, N. Y. Faun., Rept., p. 76, Pl. 16, fig. 39.
Triton porphyriticus, Holbr., *l. c.*, p. 83, Pl. 28.
Pseudotriton salmoneus, Journ. Ac. Phila. (2), I, p. 287; *Hallow., l. c.*, IV, p. 347.
Amblystoma salmoneum, Dum. & Bibr., p. 110.
Spelerpes salmoneus, Stranch, Salam., p. 83.
Spelerpes? salmonea, Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 46.
Spelerpes? porphyritica, id., ibid.
Spelerpes porphyriticus, Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 64.

This fine species of salamander has an elongated and slender body, much depressed throughout, with very little constriction at the neck, and the tail tapering very imperceptibly from the body. The skin is smooth and very slippery, everywhere under the lens showing appproximated shallow pits, but no indication of glands. As nearly as can be ascertained the pores of the head are as in *Spelerpes ruber*.

The head is flat, depressed, and rather wedge-shaped, the whole upper part to the muzzle being nearly in one plane. The muzzle is prominently and broadly truncate, though a little rounded. The sides of the head are abruptly oblique and also quite plane, the canthus rostralis being very strongly marked as an angular ridge extending forward outside the nostrils to the edge of the jaw, where it forms a slight and obtuse projection. This ridge is further indicated by a light line (always present) from the anterior angles of the eye along its summit to the margin of the jaw; the two nearly parallel. The nostrils send a narrow furrow from their outer extremity down this ridge.

The lower edge of the upper jaw viewed from before is concave, being bounded on each side by the ridge just mentioned. There is no well-defined cirrus however. The side view of the lower edge of the upper jaw is also concave. The upper jaw projects largely over the lower, most so anteriorly.

The eyes are large and prominent, distant anteriorly about one and a half lengths of the orbit; the external nostrils one orbit length apart; the inner less than this. The latter are very minute. The tongue is circular, entirely free, pedicellate, and greatly protractile.

The teeth are much as in *Spelerpes ruber*; the parasphenoidal bands perhaps rather narrow.

The body is rather vermiform, being of equal size throughout, much depressed, with a furrow from nape to above anus, where the tail rises into a sharp ridge, which continues to the tip. There are sixteen distinct

* Plate 30, fig. 6; 33; 34, figs. 1–4; 35, fig. 6; 40, fig. 3; 48, fig. 13.

costal furrows, excluding an axillary one, and five pelvic. Similar furrows can be traced to the tip of the tail. The tail is quadrate at the base, with rounded angles, broader than high, but becomes more and more compressed to the tip. The limbs are feeble and widely separated. The digits all distinct, but small; the first rather rudimentary.

In alcohol mature individuals of smaller size are of a light brownish-red on the back, the sides and beneath pale reddish-salmon color. The sides of body and tail, however, and to a less extent the back, are closely covered by a coarse, indistinct reticulation or net-work of rather dark brown, showing the lighter ground color in the areolæ, and conveying the impression of rather oblong light spots. The under parts are generally immaculate, though large specimens are sometimes finely sprinkled with dusky. There is always a light line from the eye along the canthus to the edge of the upper jaw; those of opposite sides parallel.

With increasing age the reticulation of the sides becomes obscured by the extension of the ground color of the back over the sides and the fading out of the dark markings. There is, however, generally a dull clouding of darker and a faint indication of the light spots, especially on the lower part of the sides.

This species differs from *Spelerpes ruber* in many details of external form—the more vermiform and depressed body; more widely separated fore and hind legs; one more costal furrow; the more depressed, more truncate, and broader head; larger eyes; prominent ridge from eye continued to margin of upper jaw, etc., not to mention the difference in coloration. To *S. r. flavissimus* it is related by the protuberances on the upper jaw on each side the muzzle, but these are less prominent. The fifteen costal grooves and sharply defined black spots without reticulation on the sides distinguish the former.

A specimen from Georgia (4716) differs in a more slender shape, and in having dark, horny tips to the digits, as in the aquatic Amblystomæ, as if having lived in a drier region than usual. There are only fifteen costal grooves to be distinguished.

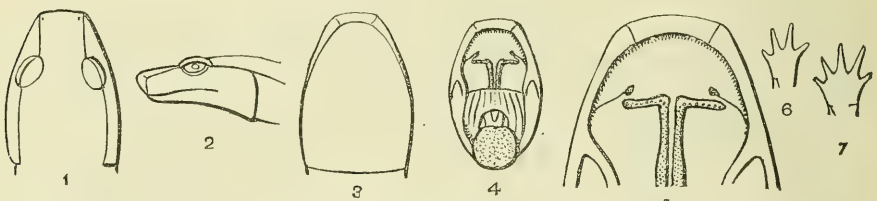

FIG. 37. *Gyrinophilus porphyriticus*. No. 3374.

Measurements of No. 3874a, in inches.

Length, measured along axis of body:	
From snout to gape	.40
From snout to gular fold	.80
From snout to armpit	1.15
Length, etc.—Continued.	
From snout to groin	3.40
From snout to behind anus	4.10
From snout to end of tail	6.50
Tail	2.40

Head:

Width of head	.55
Width of tongue	.25
Length of orbit	.20
Distance between eyes anteriorly	.30
Distance between outer nostrils	.24
Distance between inner nostrils	.15

Body:

Circumference of belly	1.85
Distance between armpit and groin	2.20

Tail:

Height of tail where highest	.40
Breadth of tail where highest	.35

Limbs:

Free portion of longest finger	.14
From elbow to tip of longest finger	.45
Free portion of longest toe	.16
From knee to tip of longest toe	.60
Distance between outstretched toes	1.90
Height of body	.54
Width	.60

There can be little doubt that, as Baird has suggested, this is the *Salamandra porphyritica* of Green. The angulation and pale color of the canthus rostralis is described accurately as well as the color of the body. The large larva, 4 inches long, is only referable to this species. The *Chondrotus microstomus*, which Holbrook and Hallowell have imagined to be Green's species, is not indicated by Green's description. It is not so large, has not the canthus rostralis, the larva is very small, and the coloration is quite different. Green's figure represents it well, though the *Amblystoma jeffersonianum* on the same plate is represented as larger—a relation of size the reverse of what usually holds in nature.

This is the only one of our Eastern salamanders which attempts self-defense. It snaps fiercely, but harmlessly, and throws its body into contortions *in terrorem*. It prefers the coolest localities throughout the Alleghany mountain region, from New York to Alabama. It is aquatic, but prefers the still waters of swamps or springs to running streams. It is common in the region whence Green procured it, while *C. microstomus* is rare, if existing at all.

Gyrinophilus porphyriticus Green.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8266	3	Carlisle, Pa	1874	Prof. S. F. Baird	Alcoholic.
3874	4	do		do	Do.
3840	1	Cannonsburgh, Pa		Dr. J. Green	Do.
3847	2	Foxburgh, Pa		Prof. S. F. Baird	Do.
3852	6	Meadville, Pa		Professor Williams	Do.
3974	1	Columbus, Ohio		Prof. L. Lesquereux	Do.
8266	10	Carlisle, Pa		Prof. S. F. Baird	Do.
3841	10	Foxburgh, Pa		do	Do.
3878	1	Upper James River		do	Do.
3749	1	Riceborough, Ga			Do.
12705	1	Lookout Mountain, Tenn	Mar. —, 1882	W. H. Foe	Do.
3842	1	Adirondack, N. Y		S. F. Baird	Do.
3374	3			E. Samuels	Do.
8812	1	Columbia, S. C		Dr. George H. Moran, U. S. A.	Do.
4716	3	Abbeville, S. C		Dr. Barrett	Do.
14468	1	Carlisle, Pa		Prof. S. F. Baird	Do.
11473	1	(?)		(?)	Do.
3869	6	Meadville, Pa		Professor Williams	Do.
3868	1	do		do	Do.
4716	1	Upper Georgia		Dr. W. L. Jones	Do.

MANCULUS Cope.

Proceed. Ac. Nat. Sci. Phila., 1869, 95–101; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 75.

Tongue free all round, boletoid. Toes 4–4. Parietal bones ossified, and without fontanelle. Premaxillaries coössified.

This genus only differs from Spelerpes in the absence of a digit from the hind foot, standing thus in the same relation to it that Hemidactylium does to Plethodon. Its typical species was formerly referred to Batrachoseps, but, besides the great difference in the tongue, the latter has a parietal fontanelle and lacks the prefrontal bone. The latter point is indicated by Eschscholtz in his atlas. In the present genus that bone is present.

The two species as yet known have a limited distribution. They are the smallest North American salamanders.

They are distinguished as follows:

Tail stout, compressed; body shorter by length of femur; black, sides light speckled ..... *M. remifer.*

Tail slender, cylindric; body longer; muzzle broader; yellowish, a dorso-lateral brown band ..... *M quadridigitatus.*

MANCULUS REMIFER Cope.

Rept. Peabody Ac., Salem, 1869, p. 84; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 76.

In this small salamander the length to the fore limbs enters that between the limbs but little over twice, indicating a less slender form than in the *S. quadridigitatus* of equal size. The head is an elongate oval, its width entering the length to the groin nearly seven times. There are sixteen costal folds, including the axillar, and these are continued upwards to near a median dorsal groove. The tail is deep and flat and marked with the lateral intermuscular grooves, besides a strong median groove above. The latter gives way to a low fin on the distal half of the tail.

The limbs are short and weak. The posterior extends forward over six grooves and half an interspace, the anterior over five and one-half, including the axillar. The fingers are slender; the interior on both limbs quite short, though distinct.

The vomerine teeth are in the two usual series, which are more posteriorly directed than is usual. The parasphenoid patches cease far behind the first mentioned, and are in narrow, very convex brushes, which are distinct from each other throughout their length. The tongue is elongate oval.

The color is black above and dark brown below; the black extends downwards and nearly meets round the neck below. The lower part

of the sides of the head, body, and basal third of tail are dusted fine white dots.

Measurements.

	M.
Length, axial, from end of muzzle to rictus oris	.00375
Length, axial, from end of muzzle to axilla	.0086
Length, axial, from end of muzzle to groin	.027
Length, axial, from end of muzzle to end of vent	.03
Length, axial, from end of muzzle to end of tail	.058
Length of fore limb	.00575
Length of fore-foot	.002
Length of hind limb	.007
Length of hind foot	.0028
Width of head	.0038
Width of body	.0032
Width of tail	.002

Only one specimen of this species has come under my observation. It was found by C. J. Maynard, of Salem, Mass., at Jacksonville, Fla., in February, 1869. It is preserved in the museum of the Peabody Academy of Sciences, which institution lent it to me for determination.

From the form of the tail it is probably a more aquatic animal than its congener *M. quadridigitatus*, and if the specimen be an average one it is not quite so diminutive.

MANCULUS QUADRIDIGITATUS Holbr.*

Cope, Proceed. Ac. Phila., 1869, p. 101; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 75.

Salamandra quadridigitata, Holbr., N. A. Herp., V, p. 65, Pl. 21.
Batrachoseps quadridigitatus, Baird, Journ. Ac. Phila. (2), I, p. 287; Strauch, Salam. p. 85; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 42.

This interesting species is among the least, if not the very smallest, of American salamanders. It is much like *Spelerpes bilineatus* in general appearance, but is still slenderer, and with longer digits.

I can see nothing distinctive in the head, except that the pedicellate tongue is very large, oval, elongated elliptical, nearly twice as long as wide, and filling the interspace of the lower jaw. The teeth appear as in *S. bilineatus*. The head is narrower than in this species.

The body is cylindrical, depressed, with fifteen costal furrows; a sixteenth would lie in the axilla, but can not be traced. The separation of the limbs varies considerably; in the largest specimen the distance from snout to axilla is contained nearly three and one-half times in that to groin; in others hardly 3 times.

The tail is slender, subquadrangular, and longer than the rest of the animal.

The digits are lengthened and slender; the longest toe contained about two and one-half times in the distance from knee to tip. The inner

* Plate 27, figs. 5–7; 35, fig. 12.

toe is entirely wanting, without a trace of it being left. There are thus but four digits to each limb.

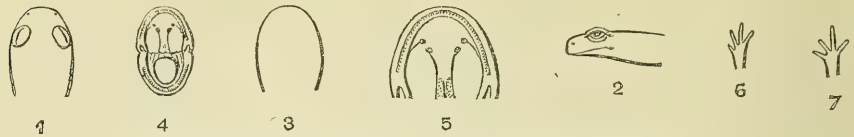

FIG. 38. *Manculus quadridigitatus.* No. 3904. Abbeville, S. C.; ⅔, ⅓.

The coloration resembles that of *S. bilineata.* There is a broad reddish or brownish-yellow dorsal stripe from head to end of tail, bounded on each side by a narrow dark line extending from the eye, fading gradually off below. The sides are closely dotted or mottled with brownish dots, the dark line referred to being merely a closer arrangement of the dots. The under parts are whitish in alcohol, finely mottled or dotted like the sides, but less closely and more indistinguishably. The median line of the belly is generally immaculate. There is almost always a narrow light line on the side from the fore to hind legs.

The light dorsal stripe is generally more or less dotted with brownish, sometimes with a tendency to a median stripe.

In one specimen the sides are distinctly dotted finely with white.

This species was referred to Batrachoseps of Bonaparte by Professor Baird, without probably having seen the type of the latter, no doubt on the faith of Bonaparte's erroneous description of the tongue of the same. It is evident that the two species ought not to be regarded as congeneric, since the *B. attenuatus* turns out to be more nearly allied to Hemidactylium than to Spelerpes.

The known range of this, one of the smallest of land vertebrates, is from middle North Carolina to the border of Texas, including Florida.

Measurements, in inches.

Length, measured along axis of body:		Head—Continued:	
From snout to gape	.11	Distance between eyes anteriorly	.09
From snout to gular fold	.25	Body: Circumference of belly	.60
From snout to armpit	.40	Tail:	
From snout to groin	1.17	Height of tail where highest	.15
From snout to behind anus	1.40	Breadth of tail where highest	.11
From snout to end of tail	3.30	Limbs:	
Tail	1.90	Free portion of longest finger	.05
Head:		From elbow to tip of longest finger	.18
Width of head	.16	Free portion of longest toe	.08
Width of tongue	.10	From knee to tip of longest toe	.23
Length of tongue	.13	Distance between outstretched toes	.72
Length of orbit	.06		

Manculus quadridigitatus Holbr.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
9337	3	Mandeville, La	Nov. 2, 1876	G. Kohn	Alcoholic.
3804	7	Riceborough, Ga		(?)	Do.
8867	2			(?)	Do.
3904	1	Abbeville, S. C		Prof. S. F. Baird	Do.
		Kinston, N. C		J. W. Milner	

SPELERPES Rafinesque.

Atlantic Journal, I, p. 22, 1832.

Spelerpes Gray, Cat. Brit. Mus. 1850, 43; Cope, Proceed. Ac. Phila., 1869, p. 104; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 60.
Cylindrosoma Tschudi, Nat. Syst. Batrachier Neuchatel, 1838.
Cylindrosoma et Bolitoglossa pars Duméril, Erp. Gén., IX.
Spelerpes et Pseudotriton Baird, Journ. Ac. Nat. Sci., I; Hallowell, *l. c.*, IV.

The tongue free, except at the glossohyal support. Palatine and parietal bones fully ossified; premaxillaries consolidated, and their spines embracing a fontanelle. Teeth small. Toes 4–5.

This is a natural genus, and is abundantly represented by individuals in the eastern district of the nearctic realm, and the Mexican of the neotropical. Its digital characters only distinguish it from Manculus, and some of the Mexican species approach that genus in the great reduction of the inner digit, which results from a diminution in the number of phalanges. The consolidation of the premaxillaries—a marked character—appears very early in the developmental history of such of the species as I have been able to study (*S. ruber*, *S. bilineatus*). The Mexican species pass their metamorphoses soonest; then such as *S. bilineatus*, and the *S. ruber* remains longest a larva.

The characters of nine species of Spelerpes are given in the following table. I know of none others, thinking that the genera Œdipus, Œdipina, and Geotriton should be maintained as distinct. Of these species four only inhabit the nearctic realm, and five are found in the Tierra Templada of Mexico, on the eastern side of the plateau. The nearctic species are all confined to the eastern region, the genus differing in its range from Plethodon in not extending to the Pacific region.

The largest species of the Spelerpes is the *S. bellii* of Mexico, which among salamanders is only exceeded in dimensions by the *Chondrotus tenebrosus*. The largest species of North America is the *S. ruber*. The species of this genus display more brilliant colors than any other of the family, yellow and red being the usual ones.

I. Vomerine teeth not continued back to parasphenoid patches, extended outwardly beyond nares.

a. Costal folds 11–12; tail cylindric; inner toes rudimental.

Plicæ 12; extremities of inner toes free; others short, thick, subequal; a canthus rostralis; muzzle truncate; vomerine series in contact; lead-colored, usually with two dorsal series of red spots; largest.....*S. bellii.*

Plicæ 12; inner toe and joint distinct, other toes well developed, cylindric; width head 5 to 6 times, and length head to axilla, 2.5 to 3 times, to groin; tail generally more elongate; black; sides, tail, and often back, gray varied; larger ..... *S. leprosus.*

Plicæ 11; inner toe not distinct; other toes very short, margined; width of head $4\frac{2}{3}$ to axilla, 1.3 to groin; tail short; black, unspotted; medium. *S. cephalicus.*

II. Vomerine teeth not continued posteriorly to the parasphenoid patches, nor exteriorly to beyond the nares.

α. Tail round; costal grooves 11–12; inner toes rudimental.

Plicæ 11 (without inguinal); width of head 4.5; length to axilla $2\frac{5}{6}$ times in length to groin; tail rather short; toes very short; upper lip more or less truncate and angulate ..... *S. chiropterus.*

αα. Tail subround; costal grooves 21; inner toes minute.

Width of head near one-seventh, length to axilla .33 of length to groin; limbs short; tail thick at base; brown, with a dark lateral band on each side; small ..... *S. multiplicatus.*

ααα. Tail compressed; costal grooves 13–14; inner toes distinct.

Plicæ usually 14; width of head less than one-sixth to groin; head to axilla well over .33 of the same; body longer, tail not keeled above proximally, comparatively short; vomerine series turned obliquely backwards; yellow, with two latero-dorsal black bands; tail dark laterally; belly yellow, immaculate; small ..... *S. bilineatus.*

Plicæ, 13; width of head equal one-sixth length to groin; muzzle to axilla more than one-third the same; tail long-keeled above; yellow, sides many black-spotted, a median dorsal series of spots; tail yellow, black-barred; belly immaculate; larger ..... *S. longicaudus.*

Plicæ 13; width of head greater than one-sixth length to groin; from muzzle to axilla considerably more than .33 length to groin; tail long-keeled above; yellow, with three black bands; tail black, yellow-barred; belly mottled; larger ..... *S. guttolineatus.*

III. Vomerine series of teeth continuous posteriorly with the parasphenoid brushes, and originating behind nares.

Costal plicæ 15–16; head wide, not more than seven times to groin, not more than twice to axilla; no canthus rostralis; tail rounded at base, not finned; large; vermilion red, black or brown spotted ..... *S. ruber.*

SPELERPES MULTIPLICATUS Cope.

Proc. Ac. Phila., 1869, p. 106; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 67.

This small species resembles in general proportions *Hemidactylium scutatum.* It is well characterized in this genus by its numerous costal plicæ and thickened, scarcely compressed tail.

The width of the head enters the length to the groin 6.75 times; the length to axilla enters thrice. The hind limb, extended, passes six intervals from the groin; the foot is wide and the toes short, especially the inner and outer; the inner has but one minute joint free. The same may be said of the anterior digits. The tail is compressed a little and considerably thickened; in the smallest specimen the terminal .75 above and .33 below are keeled; in others the superior keel is more distal.

Upper lip moderately truncate, with infranareal angles, and in one, rudimental cirri. The muzzle is rather thick and short, the head flat; in one smaller specimen the former is a little longer than in the others and the width of the head relatively less. The vomerine teeth form short series, each rather suddenly bent backwards; the pterygoid two narrow patches not approaching the vomerines, the relations in this respect being as in *S. bilineatus*.

The color in four specimens is an unspotted brown, the inferior surfaces paler, especially the gular region. In the smaller specimen above mentioned, which seems to constitute a variety, the brown color forms a broad dorsal band with dark points; the sides are of a pinkish gray, and the under surfaces light yellow.

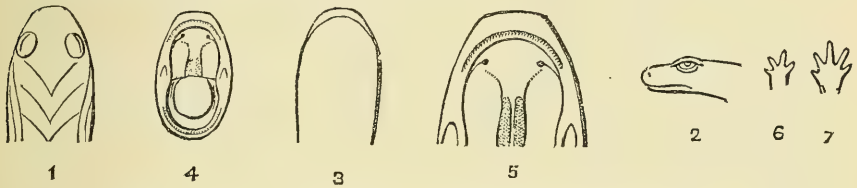

FIG. 39. *Spelerpes multiplicatus.* No. 4038. Red River, Ark.; ⅔, 1½.

Measurements of the largest specimen on the axis of the body.

	Inches.
Length from muzzle to orbit	.05
Length from muzzle to rictus	.12
Length from muzzle to axilla	.425
Length from muzzle to groin	1.53
Length from muzzle to end of tail	3.24
Length of fore limb	.233
Length of fore-foot	.08
Length of hind limb	.29
Length of hind foot	.133
Width of head at anterior angle orbits	.1
Width of head at rictus	.22
Width of body at sacrum	.15

The form of this species would indicate it to be terrestrial in its habits. Of its geographical range we have as yet little information, except that it belongs to the southern central region of the continent. Professor Cragin sent me a specimen which was taken in southern Kansas, and the types were found as below stated.

No. 4038; 5 specimens; Red River, Arkansas; Dr. L. A. Edwards.

SPELERPES BILINEATUS Green.*

Baird, Journ. Ac. Phila. (2), I, p. 287; Cope, Proc. Ac. Phila., 1869, p. 107; Strauch, Salam., p. 82; Cope, Amer. Nat. IV, p. 401; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 44; Hallowell, Journ. Ac. Phila. (2), IV, p. 346; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 66.

Salamandra bilineata Green, Journ. Ac. Phila., I, p. 352; Holbr., N. A. Herp., V, p. 55, Pl. 16; De Kay, N. Y. Faun. Rept., p. 79, Pl. 23, fig. 67.

* Plate 28, figs. 4-6.

Salamandra flavissima Harlan, Amer. Journ., 1826, p. 286.
Salamandra cirrigera Green, Journ. Ac. Phila., IV, p. 253; Holbr., *l. c.*, p. 53, Pl. 15.
Spelerpes cirrigerus Baird, *l. c.*; Strauch, *l. c.*; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 44.
Bolitoglossa bilineata Dum. & Bibr., p. 91.

In describing this species I have selected specimens from New Jersey as most like the type of Dr. Green from the same State. These are before me, but are in rather indifferent preservation.

The general characters of the group as described under *S. longicauda* apply equally here. The chief differences of form appear to consist in a rather narrower head, a more elongate body, and perhaps proportionally more slender digits. There are usually fourteen costal furrows between the limbs; a fifteenth falling over the insertion of the fore-legs, and in some specimens possibly in the axilla. The distance from snout to axilla is contained about $2\frac{2}{3}$ times in that to the groin.

There is only a slight obtuseness of the lip on each side of the muzzle to represent the cirrous appendage of the larva, which is sometimes persistent, thus presenting the characters of the supposed species *S. cirrigera.*

This species is of a clear yellow; the back with a tinge of brown on it, and this bordered on each side by a dark-brown line; sometimes very continuous, sometimes slightly broken here and there, beginning at the eye; sometimes at the muzzle and running through the eye.

The space between the lines is finely sprinkled with brown or black, sometimes only appreciable under a lens, sometimes more distinct. In most specimens the larger spots are aggregated into a narrow median or dorsal series extending to the tail; the spots on the line sometimes partially or entirely confluent. The under parts are always entirely immaculate citron yellow. The sides are very minutely dotted with blackish below the lateral stripe; in nearly all the specimens from Orange only distinguishable under the lens, and imparting a slight dusky shade. The amount of dotting here on the side is scarcely greater than that on the back.

In perhaps the greater number of specimens the mottling of the sides is greater than as described, making a broad lateral band, sometimes fading gradually out of the dorsal surface, and fading out along the belly, sometimes leaving the lower edge of the dorsal stripe well marked; occasionally the whole sides are almost as dark as the lateral stripe. There is a row of pores on the upper part of the sides, one to each interspace between the costal furrows. These show in the dusky sides as a line of whitish spots, as they do in *S. guttolineata.* This may be owing in both either to the transparency of the epidermis or to the actual presence of spots of white around these pores.

This species bears a close resemblance to *Desmognathus ochrophæa* in some of its conditions of coloration. The latter may be always distinguished independently of the generic characters, by the broad light,

generally dark bordered line which passes from the eye posteriorly obliquely to behind the angle of the jaws; and by the absence of yellow on the belly.

In the large series of specimens before me are some specimens (4735) from the vicinity of Lake Oquassa, which appear distinct from any others in the collection. They have more the general appearance of Desmognathus, though truly Spelerpes. The muzzle is rather longer and considerably higher at the end; the protuberance of the lip on the side of muzzle larger. The side of the head anterior to the eyes is much pitted with pores, scarcely appreciable in the others. The colors are darker; the dorsal stripe browner; and the mottling of the sides encroaches on the belly. The chin is quite conspicuously mottled. These differences mark a variety which Baird records in his MS. under the name of *S. b. borealis.*

A few specimens have but thirteen costal folds, and one from Georgia (4737) has that number on one side and fourteen on the other. Those with the fewer plicæ have usually shorter bodies. This is particularly the case with three specimens (3748) from Georgia, where the width of the head enters the length to the groin but little over five times. The sides are in this variety dusky, with a series of white puncta below the lateral band. The dorsal region and top of the head are abundantly punctate; sides of tail uniform black; belly immaculate. This variety connects with the *S. bilineata*, the *Salamandra cirrigera* of Green. The following description is taken from Green's type in the Museum of the Smithsonian Institution (No. 4743).

The head is depressed and anterior to the eyes. The sides, instead of tapering to a truncated muzzle, are nearly parallel to the truncate but rounded muzzle. This squareness is produced by the development of the protuberances of the upper lips on each side the muzzle, which, although partially indicated in other species, here attain their maximum of growth, becoming cirri, which are cylindrical and a little knobbed at the ends, extending downwards past the lower jaw. They are about as long as the outer finger, or .05 of an inch in length. The appearance presented is not unlike that of the muzzle of a walrus or morse. The narrow groove extending from the outer edge of the external nares passes all the way down the antero-external surface of the cirri.

There are but thirteen costal grooves, including an indistinct one in the groin. A fourteenth, if present, would fall above the insertion of the fore-leg. The distance from muzzle to axilla is contained only about two and a half times in that to the groin.

The tail, as in other species, is slender and compressed, longer than the rest of the animal.

The digits are unusually long and very slender, considerably longer than in var. *S. b. bilineatus.* The limbs are also well developed.

The color is much the same as in *s. b. bilineatus*—yellowish, with a well defined line of black on each side the back, the intermediate space

dotted with rather large and distinct spots of blackish without definite arrangement. The sides are obscurely marbled with dusky. The under parts appear to be immaculate, except some indistinct marbling on the chin.

Although the form which presents this singular character is not typical of the species, I do not consider it to be referable to any other.

Besides the original two specimens of Green, I have seen three others bearing cirri, which I took with two non-cirrigerous ones on the slope of the Black Mountains of North Carolina. These specimens are otherwise of typical character.

The cirrus is a larval character retained, which, were it permanent, would be of generic value; but it is not so, and in this case an individual feature only. The same peculiarity I have observed in two specimens of *S. chiropterus* sent by Sumichrast from Mexico, and in specimens of *S. longicaudus* and *S. guttolineatus* from the United States. The other characters of this variety, though marked, are modified in various intermediate degrees in individuals from various, especially southern, localities. The form of the tail is just as in the typical variety, though Holbrook has stated them to differ.

This species is very abundant in Pennsylvania, and extends its range, with decreasing numbers, to Maine. It differs in its habits from the *S. longicaudus* in being to a great extent a water animal, and less frequently found under bark and stones. It is only in shallow, stony brooks that it occurs, however, and can not be called aquatic in the sense in which the Tritons are. It is very active, and wriggles and runs from the pursuer in the same manner as, and generally in company with, the *Desmognathus fusca*. It is one of those species whose metamorphoses are prolonged and which remains in the larval state until nearly grown.

This species appears to be the one to which must be referred the

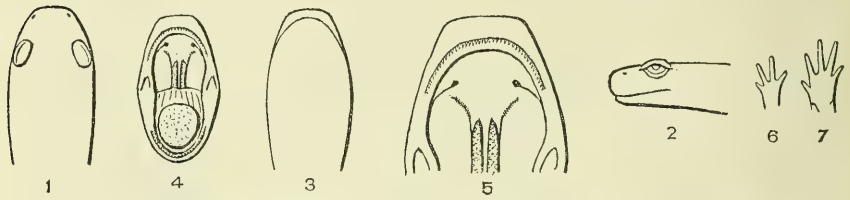

FIG. 40. *Spelerpes bilineatus* Green. No. 4456. Gloucester, Md. Twice natural size.

specimens named by Holbrook, *Salamandra haldemani*, which came from Pennsylvania. The yellow-belly and distributed dorsal spots resemble varieties of this species rather than any other.

Measurements of No. 3924, in inches.

Length, measured along axis of body:	
From snout to gape	.12
From snout to gular fold	.30
From snout to armpit	.47
From snout to groin	1.30
From snout to behind anus	1.50
From snout to end of tail	3.10
Tail	1.60
Head:	
Width of head	.20
Length of orbit	.10
Distance between eyes anteriorly	.12
Distance between outer nostrils	.12
Body:	
Circumference of belly	.75
Body—Continued.	
Distance between armpit and groin	.88
Tail:	
Height of tail where highest	.15
Breadth of tail where highest	.12
Limbs:	
Free portion of longest finger	.05
From elbow to tip of longest finger	.15
Free portion of longest toe	.08
From knee to tip of longest toe	.26
Distance between outstretched toes	.79

Measurements of No. 4734, in inches.

Length, measured along axis of body:	
From snout to gape	.12
From snout to gular fold	.29
From snout to armpit	.45
From snout to groin	1.08
From snout to behind anus	1.27
From snout to end of tail	2.97
Tail	1.70
Head:	
Width of head	.20
Length of orbit	.09
Distance between eyes anteriorly	.10
Body: Circumference of belly	.60
Tail: Height of tail where highest	.15
Limbs:	
Free portion of longest finger	.07
From elbow to tip of longest finger	.25
Free portion of longest toe	.11
From knee to tip of longest toe	.27
Distance between outstretched toes	.87

Spelerpes bilineatus Green.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3738	2	Western Pennsylvania		Dr. J. Green	Alcoholic type.
8842	1	Cincinnati, Ohio		J. N. B. Scarborough	Alcoholic.
8833	1	do		do	Do.
3718	7	Meadville, Pa		Williams	Do.
4736	9	Micanopy, Fla		Dr. T. H. Bean	Do.
4737	2	Bermuda		J. H. Darrell	Do.
3745	6	Westport, N. Y		Prof. S. F. Baird	Do.
3740	10	Essex County, N. Y		do	Do.
3744	1	Columbus, Pa		do	Do.
3748	3	Riceborough, Ga			Do.
3719	9	Meadville, Pa		Williams	Do.
4735	5	Micanopy, Fla		Dr. T. H. Bean	Do.
9463	1	Milledgeville, Ga	June, 1876	Kumlien & Bean	Do.
3746	10	Carlisle, Pa		Prof. S. F. Baird	Do.
3737	17	Coxsackie, N. Y		do	Do.
8832	1	Cincinnati, Ohio		J. N. B. Scarborough	Do.
13425	2	Garrison's, N. Y		T. Rooseveldt	Do.
13714	1	Auburn, Me	1883	G. P. Merrill	Do.
13710	1	do	1883	do	Do.
13711	1	do	1883	do	Do.
13712	1	do	1883	do	Do.
13713	1	do	1883	do	Do.
3798	2	Abbeville, S. C		J. B. Barratt	Do.
13329	17	Washington, D. C	1883	George Shoemaker	Do.
3736	4	Madrid, N. Y		(?)	Do.
14456	1	Gloucester, Md		(?)	Do.
14457	1	Abbeville, S. C		(?)	Do.
3729	1	Wilmington, Del		Dr. Bache	Do.

Spelerpes bilineatus Green—Continued.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3752	1	Nichols, N. Y		R. Howell	Alcoholic.
3753	1	Meredith Bridge, N. H		S. F. Baird	Do.
3751	6	Gloucester, Va		Rev. C. Mann	Do.
3717	5	Clarke County, Va		C. B. R. Kennerly	Do.
3741	1	Columbus, Ohio		L. Lesquereux	Do.
3726	10	Salem, N. C		J. T. Lineback	Do.
3721	60	Upper James River, Va		S. F. Baird	Do.
3742	1	Anderson, S. C		Mrs. Daniel	Do.
3725	2	Abbeville, S. C		Dr. J. B. Barratt	Do.
4719	7	Georgia		Dr. W. L. Jones	Do.
3728	2	Cleveland, Ohio		Dr. Kirtland	Do.
3747	2	Racine, Wis		R. Kennicott	Do.

Var. BOREALIS.—No. 4735; nine specimens; Kenebago Lake, Oquassa, Me., 1852; Dr. C. Girard; alcoholic.

Form CIRRIGERA.—No. 4734; two specimens; Southern States (La.?); Dr. F. Bache; alcoholic.

SPELERPES LONGICAUDUS Green.

(Plate 28, figs. 1–3; 35, fig. 11.)

Baird, Journ. Ac. Phila. (2) I, p. 287; Cope, Proc. Ac. Phila., 1869, p. 107; Strauch, Salam., p. 82; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 43; Hallowell, Journ. Ac. Phila., IV, p. 345; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 64.

Salamandra longicauda Green, Journ. Ac. Phila., I, p. 351; Holbr., N. A. Herp., V, p. 61, Pl. 19; De Kay, N. Y. Faun., Rept., p. 78, Pl. 17, fig. 41.
Spelerpes lucifuga Rafin., Atlant. Journ. I, 1832, p. 22 (fide Baird).
Cylindrosoma longicauda Tschudi, Batr., p. 93.
Cylindrosoma longicaudatum Dum. & Bibr., p. 78.

This species is slender and elongated; the head flattened and much depressed; the body depressed; the tail compressed from the base, and considerably longer than the rest of the animal.

The surface of the skin, though smooth, shows everywhere shallow pits under the microscope, and closely agglomerated granules, the ends of glands, which probably secrete a milky juice. I have not made out any satisfactory indications of patches of pores on top of the head, although there are some on the chin.

The head is flattened, though not wedge-shaped, quite plane above, and twice as wide as deep. It is longer than wide, the upper jaw overlapping the lower, especially anteriorly; the muzzle is triangular, broadly truncated anteriorly. There is a slight swelling in the upper lip on each side of the muzzle, imparting an emarginated or concave appearance to the front view of the mouth, and a concavity to the lateral outline, which posteriorly passes into a convex curve. There is a slight narrowing of the lower jaw to fit into the emargination just referred to.

The tongue is elliptical, rather longer than wide, inserted on the upper part of the extremity of a protractile pedecil; it has no other attachment whatever. The palatine teeth form a short arc which begins be-

hind and on a line with the inner border of inner nares, and curves inwards and backwards for a short distance. The parasphenoid teeth begin a short distance behind their termination (with a decided interval, however), and form in patches, in contact along the median line.

The body is elongated, the distance from snout to axilla contained $2\frac{2}{3}$ times in that to the groin. There are twelve lateral costal grooves; the posterior bifurcated above and anterior to the groin. If the furrow here be counted there would be thirteen grooves. The anterior is one interspace distant from the axilla.

The tail is very long, generally $1\frac{1}{2}$ times longer than the rest of the animal. It is much compressed from the base to the much-attenuated tip, but is nowhere as high as the body.

The limbs are much developed; the digits lengthened, narrow, linear, cylindrical, depressed, and swollen slightly into bulbs at the ends. There is no basal connecting membrane. The third and fourth toes are longest, the latter perhaps longer of the two; the second and fifth are nearly equal. The first finger and toe are very short, though not rudimentary.

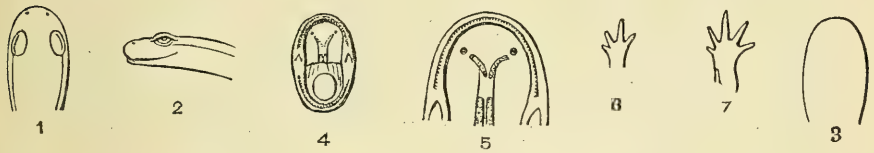

FIG. 41. *Spelerpes longicaudus.* No. 4085. Lancaster, Ohio; ½.

The ground color of this species is of a clear bright yellow, paler beneath, the back and sides irregularly sprinkled with black specks looking like grains of rather coarse gunpowder. These are generally (but not always) more thickly crowded along the sides, sometimes almost forming a distinct spotted band on the sides of the tail; these black spots are generally aggregated into a series of vertical bands. In younger specimens, and many older ones, the spots above are arranged in three rather irregular lines, one median and two lateral larger ones. The muzzle and entire under parts are immaculate.

In old individuals there is sometimes a suffusion of reddish-brown among the spots on the sides, obscuring their outlines. The shade of yellow varies sometimes to a reddish tinge. Sometimes the black spots on the sides are arranged in a somewhat reticulated manner.

This beautiful animal is not very active in its habits, and is almost always found in rocky ground and in fissures and caves in cliffs. I have never seen it in the water. It was described by Rafinesque from a specimen from a cavern in Kentucky. Its distribution is throughout the middle latitudes, rather representing the *S. guttolineatus* of the far Southern States.

I have recorded a specimen of this species from Tennessee (American Naturalist, 1871, p. 401), in which the balancers were persistent, as in the cirrigera form of *Spelerpes bilineatus*.

Measurements of No. 3716, in inches.

Length, measured along axis of body:	
From snout to gape	.22
From snout to gular fold	.50
From snout to armpit	.75
From snout to groin	2.08
From snout to behind anus	2.35
From snout to end of tail	5.05
Tail	2.70
Head:	
Width of head	.33
Width of tongue	.15
Length of tongue	.22
Length of orbit	.15
Distance between eyes anteriorly	.20
Distance between outer nostrils	.15
Distance between inner nostrils	.10
Body:	
Circumference of belly	1.10
Distance between armpit and groin	1.35
Tail:	
Height of tail where highest	.25
Breadth of tail where highest	.19
Limbs:	
Free portion of longest finger	.11
From elbow to tip of longest finger	.40
Free portion of longest toe	.15
From knee to tip of longest toe	.51
Distance between outstretched toes	1.65

Spelerpes longicaudus Green.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8842	2	Cincinnati, Ohio		J. N. B. Scarborough	Alcoholic.
3735	1	Columbus, Ohio			Do.
3732	3	Meadville, Pa		Williams	Do.
8846	1	Cincinnati, Ohio		J. N. B. Scarborough	Do.
8821	1	Union County, Tenn		do	Do.
8803	1	Augusta, Ga		William Phillips	Do.
8826	1	Franklin County, Tenn		J. N. B. Scarborough	Do.
3860	2	Pittsburgh, Pa			Do.
4085	3	Lancaster, Ohio		Professor Lesquereux	Do.
11456	1	Carlisle, Pa			Do.
14447	1	Wytheville, Va	1885	Col. M. McDonald	Do.
3716	5	Carlisle, Pa	1849	S. F. Baird	Do.
3730	1	Highland County, Ohio		Matthews	Do.
3731	3	West Northfield, Ill		R. Kennicott	Do.
3739	3	Southern Illinois		do	Do.
		Washington, D. C		Dr. E. E. Galt	

SPELERPES GUTTOLINEATUS Holbrook.

Baird, Journ. Ac. Phila. (2), I, p. 287; Cope, Proc. Ac. Phila., 1869, p. 107; Strauch, Salam., p. 82; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 45; Hallow., Journ. Ac. Phila., IV, 346; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 65.

Salamandra guttolineata Holbr., N. A. Herp., V, p. 29, Pl. 7.
Cylindrosoma guttolineatum Dum. & Bibr., p. 79.

This species in its general proportions, shape, etc., is very similar to *S. longicaudus*. It appears to be rather stouter, and the head a little broader. The eyes are larger, the toes shorter, etc. The protuberances of the upper lip are rather larger, which gives a more emarginated outline to the jaw when viewed from before.

There are thirteen well-marked costal grooves, a fourteenth falling just above the insertion of the arm. The most posterior falls in the groin.

This species is of a brownish-yellow above, beginning at the muzzle, including the upper eyelids and extending to the tip of the tail. On the back it occupies nearly one-third the circumference of the body. It

is divided centrally by a longitudinal dark brown line, beginning as a few dots, on the top of the head, then uniting into a continuous stripe, which extends to the rump, and is a little narrower than, or about equal to, the two light stripes into which it divides the color of the back. The light dorsal stripe is bordered on each side by a continuous dark stripe well defined on the upper edge. The under parts are yellowish in alcohol, distinctly mottled or vermiculated with brown in about equal proportions. In the present specimen there is no distinct light line below the brown of the sides, which breaks up gradually below, passing into the reticulation described. There is a single light spot in the darkest part of the sides, one to each intercostal section. The sides of the tail are dark brown, with vertical light bars analogous with the white spots just described.

In other specimens the dark brown which borders the yellowish of the back is sharply defined on its lower margin, also forming a continuous line of variable diameter, with a series of white spots, one to each space, between the costal furrows. Below this again is another continuous, quite well-defined light stripe, after which succeeds the mottling described. In this case there are three black stripes, one median dorsal, and two lateral; and four light stripes, two median, of a brownish-yellow color, and two lateral, whitish in alcohol.

The comparison of form has already been made with *S. longicaudus*. The color differs essentially in the vermiculation, with brown beneath, instead of being perfectly immaculate. If the varieties of *S. longicaudus* having three series of dorsal dots had these united into continuous stripes there would be some resemblance to the present species. Such is, however, never the case. The tail, instead of being yellow, with narrow vertical dark lines, is dark, with narrow vertical light ones.

I have found a cirrigerous form of this species in North Carolina.

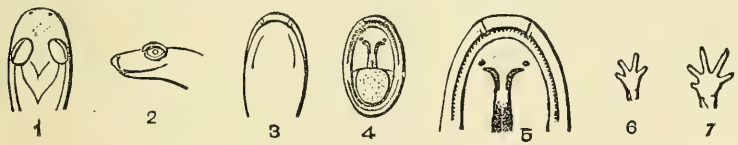

FIG. 42. *Spelerpes guttolineatus*. No. 3723. Eutaw, Ala.; ½

Measurements of No. 3723, in inches.

Length, measured along axis of body:		Body:	
From snout to gape	.21	Circumference of belly	.90
From snout to gular fold	.50	Distance between armpit and groin	1.18
From snout to armpit	.75	Tail: Height of tail where highest	.20
From snout to groin	1.90	Limbs:	
From snout to behind anus	2.25	Free portion of longest finger	.09
From snout to end of tail	5.25	From elbow to tip of longest finger	.39
Tail	3.00	Free portion of longest toe	.13
Head:		From knee to tip of longest toe	.49
Width of head	.32	Distance between outstretched toes	1.35
Length of orbit	.15		
Distance between eyes anteriorly	.19		

Spelerpes guttolineatus Holbr.

Catalogue number.	No. of spec.	Sex and age.	Locality.	When collected.	From whom received.	Nature of specimen.
3723	3	.....	Eutaw, Ala	.....	Professor Winebell	
3727	1	.....	Salem, N. C	.....	I. T. Lineback	
3749	3	.....	Riceborough, Ga	.....	Dr. Jones	
4733	1	.....	Abbeville, S. C	.....	Dr. Barratt	
3734	1	.....	Mississippi	.....	Colonel Wailes	
5720	1	.....	Anderson, S. C	.....	Mrs. Daniels	
3733	4	Larva.	New Madrid, Mo	.....	R. Kennicott	

This species was found abundantly by the writer in the upper valley of the French Broad River, in North Carolina, at an elevation of 2,500 feet above the sea. Dr. A. K. Fisher, of the U. S. Agricultural bureau, also found this species in Virginia, only eight miles south of Washington, D. C., a most remarkable extension of its range.

The specimen recorded in Dr. Yarrow's check-list as from Lancaster, Ohio, belongs to the *S. longicaudus*.

SPELERPES RUBER Daudin.

(Plates 29, 30, figs. 1–5; 31, figs. 1–5; 32, figs. 1–3; 35, figs. 7–10; 40, figs. 1, 2; 45, fig. 6; 48, fig. 16.)

Cope, Proceed. Ac., Phila., 1869, p. 107; Strauch, Salam., p. 83; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 62.

Salamandra rubra Daud., Rept., VIII, p. 227, Pl. 92, fig. 2; Holbr., N. A. Herp., V, p. 35, Pl. 9; De Kay, N. Y. Faun. Rept., p. 80, Pl. 17, fig. 43.
Salamandra maculata Green, Journ. Ac. Phila., I, p. 350.
Salamandra subfusca Green, *l. c.*, p. 351.
Salamandra rubriventris Green, *l. c.*, p. 353 (*nec.* Daud.).
Pseudotriton subfuscus Tschudi, Batr., p. 95.
Pseudotriton ruber Baird, Journ. Ac. Phila. (2), I, p. 286; Hallowell, *l. c.*, IV., p. 347.
Spelerpes rubra Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 45.
Bolitoglossa rubra Dum. & Bibr., p. 89, Pl. 93, fig. 2.
Pseudotriton flavissimus Hallow., Proc. Ac. Phila., 1856, p. 130.
Larva:
Siren operculata Pal. de Beauv., Amer. Phil. Trans., IV, p. 279, Pl. —, fig. 3.
Proteus neocæsareanus Green, *l. c.*, p. 358.

The form of this species varies with its age, the very old ones being nearly as stout as *Ambystoma punctatum*; more so than *A. opacum*. The more immature, however, are rather slender.

The skin is perfectly smooth and lustrous. There are no indications of glands secreting a milky juice, as in Amblystoma, but the skin is everywhere beset with shallow pits, closely set. The eye is encircled by a series of pores. These extend anterior to those on the side of the head to the nostrils, and are more crowded. The lower edge of the lower jaw is encircled by a single series of pores, and there are two other series, nearly straight, which start from the point of the chin and diverge backwards.

The head is depressed, triangular, almost wedge-shaped viewed laterally, and rather pointed; more truncate in the young. The upper jaw is projecting and overlaps the lower. The gape is about straight. The end of the upper jaw is flattened obliquely a little, visible only from below. The nostrils are very small, placed more laterally than superiorly, and a little below the anterior end of the rounded canthus rostralis. The eyes are directed antero-laterally, so that the lines of the upper eyelids would intersect before reaching the tip of the nose.

There is only a slight constriction at the neck, the entire animal from head to rump being nearly of the same diameter, and the body passes insensibly into the tail. This is quadrate or nearly square at the base (with rounded corners), but becomes more and more compressed to the pointed tip. The dorsal surface of the tail rises into an acute ridge for the posterior two-thirds, the ventral for one-third. There are fifteen costal grooves, including one in the groin. If continued to the axilla there would be sixteen, but there is no distinct axillary one. The vertical grooves of the tail are distinct at the base of the tail, but soon become indistinct.

As stated, old specimens have a proportionally larger body than younger.

The limbs are all very weak; the digits feeble. The third finger is longest, then the second, fourth, and first. The third and fourth toes are nearly equal, then the second. The first digits are quite rudimentary, especially the first toe. The younger specimens appear to have proportionally longer digits and more slender limbs.

The tongue is a nearly circular disk, entirely free, supported on a slender pedicel like a mushroom, and capable of being extended beyond the mouth. The palatine teeth are transverse, just behind the nostrils (by one diameter), and form an abrupt rectangle with each of the series on the parasphenoid bone, which widen behind and leave a free channel down the median line. This free space anteriorly is as wide as the diameter of the inner nares, but like the patches of teeth widens a little behind. The space is encroached upon by the plates of parasphenoid teeth with age.

The inner nostrils are minute, about transversely elleptical and continuous, with a well-defined narrow groove running out to the margin of the jaw. They are situated about opposite the center of the transverse portion of the teeth, the length of which may be about three times as great as the major axis of the nostrils.

The colors of the younger specimens of this species in alcohol are a pale salmon-yellow, lighter beneath; the back and upper part of the sides sprinkled irregularly and thickly with sharply-defined blackish spots, looking like grains of coarse gunpowder. These spots vary in size with the specimen, and are generally larger towards the dorsal line. With age, and sometimes in younger specimens, the borders of these spots are less distinctly defined, and the ground color between them

becomes suffused with a kind of purplish-brown. The belly is generally immaculate until the animal is quite old, when it is finely sprinkled with dots like grains of fine powder.

The color of a fresh specimen is as follows. It is fully grown, and was taken April 7, 1848

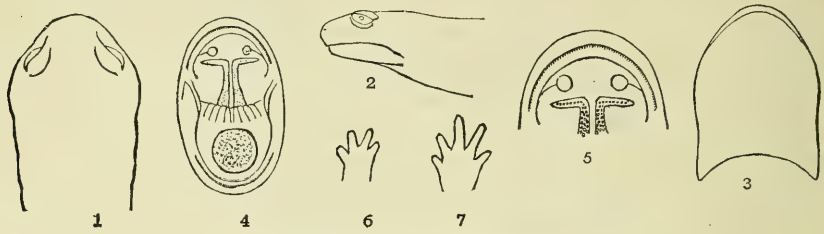

FIG. 43. *Spelerpes ruber*. No. 7903. Carlisle, Pa.; ½.

Pupil small, elliptical, major axis horizontal, brassy, with horizontal dark line. General color dark salmon-red. Whole upper parts marked with rounded spots, largest along back, about size of the eye and less, of black or dark. Between these spots is a clouding of dark reddish-brown, as if the black of upper parts had run after being first put on. Frequently, however, there is an obscure areola of the ground color around the spots; on sides of body and tail, external portion of limbs, less of the interstitial dark reddish-brown. Whole under surface sprinkled with minute black dots, larger towards the chin. Extreme edge of snout blackish, as also of lower jaw to a less degree.

Individuals vary somewhat in coloration; sometimes the dots on the belly are more aggregated towards the center, sometimes the interstitial color on back purer, so as to define spots better, while again, on the other hand, the whole upper parts are so much shaded with the reddish-brown as to nearly obscure the black spots.

The eye can be retracted or protruded as in the figures, and also concealed by the approximation of the lids. The transparent lower lid can be brought up and over lower half of the eyeball.

In young individuals the colors are much purer; the whole body being of orange, of different shades in different individuals; darker above, with spots of black on upper half of body, larger along back, irregularly distributed, beneath generally unspotted. The lower jaw with a row of spots around its margin.

Observations.—This is an abundant species throughout the United States east of the Mississippi River as far north as Maine, and corresponding latitudes in Canada, and south into Texas and Florida. It chiefly abounds in the hilly and mountainous sections. It is especially aquatic in its habits, and is found on the ground only after rains. It is not unfrequently found under bark of fallen trees in damp situations, but its chief haunts are cold springs. Here, beneath stones, it may be always found, occupying, if possible, the fissure from which the limpid water rises, and displaying its beautiful hues through the trans-

parent medium with the brilliancy of a strange exotic, rather than the pallor of a dweller in the chilly depths and dark recesses of a cave. They walk deliberately, and swim with some activity, moving, as do other salamanders, with the limbs pressed to the sides and the body and tail undulating laterally. Their movements are not so active as those of some other species. They are very harmless and, though I have handled a great number of them, have never seen them attempt to bite. Their food consists of insects.

Varieties.—Occasionally a specimen is found which is of a uniform grayish-brown. Dr. E. E. Galt sent me such a one from Staten Island, New York. Two forms have been distinguished by Professor Baird which may rank as subspecies: the *S. ruber sticticeps* and the *S. ruber montanus*. They are described below.

The manner in which the characters which distinguish these subspecies are found singly in various individuals illustrates well the condition of a protean species. Thus of the specimens with sixteen costal plicæ referable to *S. r. montanus*, where the width of the head may be one-sixth the length to the groin, two specimens measure the same, $6\frac{1}{2}$ and $6\frac{2}{3}$ in the same, and another $6\frac{3}{4}$, and another (3848) 7 times. In one the posterior part of the parasphenoidal patch is widened, as in the usual form. In two specimens (3870–7031) the sixteenth plica falls over the femur and does not descend before it; the vomerine series of both are angulated. In 7031*a*, from the same locality as 7031, all the characters are those typical of *S. r. montanus*.

In two specimens having the head and coloration of var. Ruber, from Eutaw, Ala., one has fifteen plicæ and angulate teeth, the other sixteen plicæ and curved series of teeth. In a number of *S. r. ruber* from Abbeville, S. C., one has sixteen plicæ. In this variety the width of the head enters the length to groin usually five times, but varies to $5\frac{1}{2}$, $5\frac{2}{3}$, and in 7023, $6\frac{1}{2}$ times.

In the type of *P. flavissimus*, this relation is 1 to $6\frac{1}{2}$, with but fifteen plicæ; the truncation of the muzzle is less than described, and there are no cirri. In var. Sticticeps a trace of the same is visible. The peculiar coarse and sparse spotting in this var. and in *S. r. montanus* is seen in Ruber No. 7073 (half grown).

The uniform color of *S. r. sticticeps* is nearly equaled by No. 7023, and the white punctulation of the lips by 7073 (large), though none are similar in the punctulation of the front; in 1840, from Eutaw, Ala., the abdomen and gular region are similarly punctulate.

As regards the size of the eyes in *P. flavissimus*, their longitudinal diameter measures 1.5 the width between their anterior canthi. These specimens are both small. In several small var. Ruber the measurement is the same, and in the smaller of the *S. r. sticticeps;* in the larger of the latter and of Ruber this measurement is as 1:2. Nevertheless, in a number of var. Ruber which have just completed their metamorphosis the proportion of front to eye is also 2:1 (No. 3849).

These varieties are, however, not difficult to recognize, especially as I have observed, the *S. r. montanus*.

Proportional dimensions of No. 3837.

Head:
- Length of gape of mouth to its width ..... about half.
- Width to distance from snout to gular fold ..... contained 1⅓ times.
- Width to distance from snout to groin ..... about 6 times.
- From snout to gular fold contained in distance from snout to groin .... 4½ times.
- Distance anteriorly between eyes in length of orbit ..... 2 orbits.
- Distance from eyes to nostrils in length of orbit ..... 1 orbit.
- Distance between external nostrils in length of orbit ..... about 1 orbit.
- Distance between internal nostrils in length of orbit ..... less than 1 orbit.

Limbs:
- Free portion of longest finger contained in distance from elbow to tip. 4 times.
- Free portion of longest toe contained in distance from knee to tip ..... 3 times.
- Distance between outstretched toes in length from snout to groin ..... one-half.

Tail:
- Length from behind anus to rest of animal ..... 1⅜ times.
- Length from behind anus to total length ..... two-fifths.

Body:
- Width compared with that of head ..... rather broader.
- Number of costal furrows (including inguinal) ..... 15.

Measurements of No. 3837, in inches.

Length, measured along axis of body:		Body:	
From snout to gape	.28	Circumference of belly	2.15
From snout to gular fold	.70	Distance between armpit and groin	2.10
From snout to armpit	1.00	Tail:	
From snout to groin	3.00	Height of tail where highest	.45
From snout to behind anus	3.50	Breadth of tail where highest	.40
From snout to end of tail	5.60	Limbs:	
Head:		Free portion of longest finger	.10
Width of head	.55	From elbow to tip of longest finger	.40
Width of tongue	.22	Free portion of longest toe	.15
Length of orbit	.14	From knee to tip of longest toe	.51
Distance between eyes anteriorly	.26	Distance between outstretched toes	1.50
Distance between outer nostrils	.15		
Distance between inner nostrils	.12		

Spelerpes ruber flavissimus Hallow.

Pseudotriton flavissimus Hallow., Proceed. Ac. Nat. Sci. Phila., 1850, 130.

The form and proportions, excepting about the head, are so similar to those of *S. ruber*, that it is unnecessary to repeat these characters. The digits are rather long, as usual in young *S. ruber*. The outer ones, however, appear proportionally longer than in the latter. The head, viewed from above, is narrower and more truncate. It is arched but not wedge-shaped, depressed, the muzzle being much higher than in *S. ruber*. Each side of the truncated snout is bordered by a vertical ridge, which is a little exterior to the outer nostrils, and descends a

little below the level of the jaw, looking like a fang when viewed laterally. Viewed from in front, the lower outline of the muzzle is strongly concave, bordered on each side by the downward extension of this ridge. There is a slight indentation of the side of the jaw behind this ridge, and there is a fine linear channel leading down the back of this ridge from the outer margin of the external nostrils. A similar channel, but no ridge, is seen in *P. ruber*.

The outline of the upper jaw, as viewed from below, is decidedly angular anteriorly instead of rounded.

The eyes are unusually large and prominent for this section of salamanders, and are separated anteriorly by little more than one orbit's length. The two parasphenoidal ranges of teeth are in contact anteriorly, as in *S. r. montanus*, without the interval of *S. r. ruber*.

There are fifteen costal furrows, excluding an axiliary one. The tail is a little more than half the rest of the body.

In alcohol the color is light brownish-red, paler beneath; the upper parts and sides thinly but quite uniformly sprinkled with small, rounded, well-defined, blackish dots; very few of them on the head.

As stated, this variety is distinguished from *S. ruber*, as well as *S. r. montanus* and *sticticeps*, by the shape of the head, the angulation of the upper lip, the much larger and more approximated eyes. The scantiness of the black specks is more as in *S. r. montanus*, from which again it is distinguished by fifteen instead of sixteen costal grooves.

Proportional dimensions.

Head:
- Width to distance from snout to groin ..... about 6 times.
- From snout to gular fold contained in distance from snout to groin ..... about 4½ times.
- Distance anteriorly between eyes in length of orbit ... scarcely more than once.
- Distance from eyes to nostrils in length of orbit ..... about once.
- Distance between external nostrils in length of orbit ..... about one time.

Limbs: Distance between outstretched toes in length from snout to groin ..... rather more than half.

Body: Number of costal furrows (including inguinal) 15

Measurements, in inches.

Length, measured along axis of body:	
From snout to gape	.22
From snout to gular fold	.45
From snout to armpit	.65
From snout to groin	1.85
From snout to behind anus	2.10
From snout to end of tail	3.30
Tail	1.20
Head:	
Width of head	.30
Length of orbit	.11
Distance between eyes anteriorly	.13
Distance between outer nostrils	.11
Head—Continued:	
Distance between inner nostrils	.08
Distance from eye to nostrils	.10
Body: Distance between armpit and groin	1.17
Tail: Height of tail where highest	.20
Limbs:	
Free portion of longest finger	.08
From elbow to tip of longest finger	.30
Free portion of longest toe	.10
From knee to tip of longest toe	.35
Distance between outstretched toes	1.05

Spelerpes ruber sticticeps Baird.

Proceed. Ac. Phila., 1869, p. 108. (Name only.)

This variety in all its details of shape, proportions and general structure resembles *P. ruber*. The limbs, however, are considerably smaller and weaker, and the external nostrils seem to be farther apart. There are fifteen costal furrows, excluding the axillary.

The color in alcohol is a dark reddish-brown or brownish-red above; lighter red beneath. The color of the upper parts is very uniform and continuous, though a careful examination shows some very obsolete rounded spots of darker on the sides. The sides and beneath are everywhere sprinkled with minute blackish dots. The head is uniformly colored like the back, without dark spots, but its sides and anterior portion are closely sprinkled with whitish specks, which are very distinct and characteristic.

This variety differs somewhat in form from *S. ruber*, as stated. It can be separated from the latter by the small whitish specks on the muzzle in the uniform ground color, typical *S. ruber* always having larger black spots, without any white. The color above is deeper and more continuous than in *S. ruber* without the distinct dorsal spots always distinguishable in it. The ground color appears to be of a much deeper red than in *S. ruber*.

Proportional dimensions.

Head
- Length of gape of mouth to its width ..... three-fourths.
- Width to distance from snout to groin ..... nearly 6 times.
- From snout to gular fold contained in distance from snout to groin .... 4⅓ times.
- Distance anteriorly between eyes in length of orbit ..... twice.
- Distance between external nostrils in length of orbit ..... 1½ times.

Limbs:
- Free portion of longest finger contained in distance from elbow to tip .. 5 times.
- Free portion of longest toe contained in distance from knee to tip ..... nearly 4 times.
- Distance between outstretched toes in length from snout to groin. nearly twice.
- Distance between outstretched toes in length from snout to behind anus ..... more than twice.

Body: Number of costal furrows (including inguinal) 15

Measurements, in inches.

Length, measured along axis of body:		Body:	
From snout to gape	.30	Circumference of belly	1.50
From snout to gular fold	.57	Distance between armpit and groin	1.65
From snout to armpit	.85	Tail: Height of tail where highest	.40
From snout to groin	2.50	Limbs:	
From snout to behind anus	2.85	Free portion of longest finger	.07
From snout to end of tail	4.90	From elbow to tip of longest finger	.35
Tail	2.05	Free portion of longest toe	.12
Head:		From knee to tip of longest toe	.45
Width of head	.43	Distance between outstretched toes	1.35
Length of orbit	.11		
Distance between eyes anteriorly	.22		
Distance between outer nostrils	.16		
Distance between inner nostrils	.10		

Spelerpes ruber montanus Baird.

Pseudotriton montanus Baird, Journ. Philadelphia Academy, I, 287–293; Gray. *l. c.*, p. 46.

The external characters of this subspecies are much as in *P. ruber* as to pits, smoothness, etc.

The form of this animal is more like that of *Gyrinophilus porphyriticus* in being elongated, cylindrical, and with the tail nearly equal to the distance from the head to the groin.

The head is rather small and narrow. The proportion of eyes, etc., much as in *S. ruber*. The snout is, however, more abruptly truncated, showing the nostrils on each side at the corner formed with the side of the head, and with an indistinct ridge running down to the jaw as in *G. porphyriticus*, but less marked. The top of the head is more convex, and not flattened between the eyes. The tongue is a circular pedunculated disk. The teeth curve gently from behind the inner nares to the parasphenoid bone, not at an angle, and the two longitudinal series are so close continuously as to exhibit no furrow of separation, and very little of one behind. The palatine portion does not extend outwards beyond the outer border of the inner nostrils.

Professor Baird described this species in 1849 from a single adult specimen caught in the South Mountain, near Carlisle, Pa. Since then several others from different localities have been obtained, and after the renewed examination of many specimens of *S. ruber* I am satisfied of its distinction as a subspecies. The coloration is always appreciably different in the very dark iris without longitudinal bar of Montanus, compared with the brassy-yellow iris with longitudinal dark bar of Ruber. The ground color above is uniformly and continuously brownish-salmon, much as in *G. porphyriticus*, with a few well-defined circular spots. In Ruber where the ground color has become dark reddish-brown, it is always mottled with lighter, and the larger and more numerous dark spots are more obsolete in their outline.

The head of Montanus is narrower and much more arched transversely. The snout is more truncate. The two series of teeth on each side the parasphenoid bone come closer, so as to be almost in contact, without the interval of *S. ruber*.

The body and tail are more slender and elongated; the latter proportionally considerably longer. There are 16 costal furrows, excluding an axillar one, instead of 15, as in *S. ruber*.

There are 16 distinct costal grooves, excluding any in the axilla. The tail shows similar furrows at first, but they soon become indistinct. It is quadrate at the base, then gradually becomes more and more compressed, with a sharp ridge towards the end, as in *S. ruber*. Its length is nearly equal to the distance from the snout to the groin.

The limbs are not appreciably different from what has been described in *S. ruber*.

The color of the type specimens, as preserved in alcohol, is a uniform

continuous brownish-salmon above, including the limbs; the under parts, from the middle of the sides, rather abruptly pale salmon. The dark portions are marked with circular, thinly scattered, well-defined dark brown or black spots. The belly is immaculate.

In life this same specimen had the ground color reddish-brown; beneath, deep salmon. The iris dark reddish-brown, almost black, with faint mottlings of bronze on the inner border, and without any horizontal dark bar.

The difference of form and color are appreciable in young as well as old specimens.

The distribution of this form is in the Alleghany Mountains from Pennsylvania to South Carolina.

Proportional dimensions.

Head:
- Length of gape of mouth to its width ..... about three-fourths.
- Width to distance from snout to gular fold ..... about 1⅓ times.
- Width to distance from snout to groin ..... about 5⅔ times.
- From snout to gular fold contained in distance from snout to groin .. about 4⅓ times.
- Distance anteriorly between eyes in length of orbit ..... 1⅔ times.
- Distance from eyes to nostrils in length of orbit ..... 1 time.
- Distance between external nostrils in length of orbit ..... 1 time.
- Distance between internal nostrils in length of orbit ..... less than 1 time.

Limbs:
- Free portion of longest finger contained in distance from elbow to tip ..... nearly 4 times.
- Free portion of longest toe contained in distance from knee to tip .. about 3½ times.
- Distance between outstretched toes in length from snout to groin .. about 1⅔ times.

Tail:
- Length from behind anus to rest of animal ..... 1⅓ times.
- Length from behind anus to total length ..... three-sevenths.

Body:
- Width compared with that of head ..... rather less.
- Number of costal furrows, including axillary and inguinal ..... 16.

Measurements, in inches.

Length, measured along axis of body:		Body:	
From snout to gape	.30	Circumference of belly	1.90
From snout to gular fold	.65	Distance between armpit and groin	1.75
From snout to armpit	.94	Tail:	
From snout to groin	2.85	Height of tail where highest	.42
From snout to behind anus	3.25	Breadth of tail where highest	.32
From snout to end of tail	5.75	Limbs:	
Of tail	2.50	Free portion of longest finger	.10
Head:		From elbow to tip of longest finger	.38
Width of head	.46	Free portion of longest toe	.15
Length of orbit	.15	From knee to tip of longest toe	.50
Distance between eyes anteriorly	.25	Distance between outstretched toes	1.75
Distance between outer nostrils	.17		
Distance between inner nostrils	.10		

Spelerpes ruber ruber Daudin.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8841	1	Cincinnati, Ohio		J. N. B. Scarborough	Alcoholic.
5392	1	Pointsville, N. J		N. H. Bishop	Do.
7903	10	Carlisle, Pa		Prof. S. F. Baird	Do.
3865	2	Delaware County, Pa			Do.
7820	3	Washington, D. C		Dr. E. Coues, U. S. A	Do.
8811	6	Columbia, S. C		Dr. George N. Moran	Do.
8818	1	Hamilton County, Ohio		J. N. B. Scarborough	Do.
8339	1	Goldsborough, N. C		H. W. Welsher	Do.
9329	1	Trenton, N. J		Dr. C. C. Abbott	Do.
9555	5	Aux Plains River, Ill		R. Kennicott	Do.
3837	8	Carlisle, Pa		Prof. S. F. Baird	Do.
9553	1				Do.
3845	5	Foxburgh, Pa		Prof. S. F. Baird	Do.
3854	3	Meadville, Pa		Williams	Do.
3848	3	Abbeville, S. C		Dr. J. B. Barratt	Do.
9120	2	Morgantown, N. C		Dr. George N. Moran	Do.
9554	2				Do.
3934	4	Carlisle, Pa		Prof. S. F. Baird	Do.
3863	2	Anderson, S. C		Mrs. M. E. Daniel	Do.
4024	1	Columbus, Ga		Dr. Gesner	Do.
1840	1	Fort Benton, Mo		Dr. F. V. Hayden	Do.
13313	1	Washington, D. C	Dec. 20, 1883	Geo. Shoemaker	Do.
3862	3	Gloucester, Va		Rev. C. Mann	Do.
11961	2	Milton, Fla		S. T. Walker	Do.
5948	1	Beaufort, N. C		Dr. Wm. Stimpson	Do.
11583	1	Indian Key, Fla		(?)	Do.
1846	1	Fort Towson, Ark		Dr. Edwards	Do.
3637	4	Prairie Mer Rouge, La		Jas. Fairie	Do.
3853	4	Tyree Springs, Tenn		Prof. R. Owen	Do.
	80				

GENERAL SERIES.

7039	1	(?)			Alcoholic.
3854	2	Meadville, Pa		Williams	Do.
9328	2	Trenton, N. J		Dr. C. C. Abbott	Do.
9330	1	Virginia	Feb. 20, 1877	F. F. Talbot	Do.
10898	1	(?)			Do.
2903	37	Carlisle, Pa		Prof. S. F. Baird	Do.
3835	141	do		Dr. Stevens	Do.
13583	1	Rawley, Va	Sept., 1883	Ben. Miller	Do.
3849	9	Foxburgh, Pa		S. F. Baird	Do.
11705	2	do		do	Do.
3866	2	Clarke County, Va		C. B. R. Kennerly	Do.
8844	2	Fauquier County, Va		C. W. Sheurmann	Do.
14120	1	Wytheville, Va	1885	Col. M. McDonald	Do.
7073	7	Abbeville, S. C		(?)	Do.
3859	7	Carlisle, Pa		Prof. S. F. Baird	Do.
14455	1	(?)		(?)	Do.
14467	1	(?)		(?)	Do.
14476	1	(?)		(?)	Do.
14478		(?)		(?)	Do.
3844	2	Summerville, S. C		J. W. Nair	Do.
3837	10	Carlisle, Pa	1848	S. F. Baird	Do.
3845	2	Centre County, Pa		S. B. Brugger	Do.
4714	1	Pittsburgh, Pa		Mr. Fahnestock	Do.
3872	1	Columbus, Ohio		L. Lesquereaux	Do.
3873	5	Anderson, S. C		Mrs. M. E. Daniel	Do.
3851	5	Salem, N. C		J. T. Lineback	Do.

Spelerpes ruber flavissimus Hallow.

4713	1	Summerville, N. C		J. C. MacNair	

Spelerpes ruber sticticeps. Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
11475	2	Georgia		Dr. W. L. Jones	Alcoholic.

Spelerpes ruber montanus Baird.

3839	2	South Mountain, Carlisle, Pa.	1848	Prof. S. F. Baird	Alcoholic (type).
3848	2	Salem, N. C.		J. T. Linehack	Do.
4715	1	Abbeville, S. C.		Dr. J. B. Barratt	Do.
3870	1	Tyree Springs, Tenn.		Prof. R. Owen	Do.
5948	1	Beaufort, N. C.		Wm. Stimpson	Do.
7031	1	Hillsborough, N. C.		M. A. Curtis	Do.
8834	1	Union County, Tenn.		J. N. B. Scarborough	Do.

AUTODAX Boulenger.

Ann. and Mag. Nat. Hist. 1887, p. 67.

Anaides Baird, Iconogr. Encycl., II, 1849, p. 256; Girard, U. S. Expl. Exped., Rep., p. 8; Cope, Proceed. Ac. Phila., 1869, p. 109; Strauch, Salam., p. 74; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 52; nom. præoccupatum.

Tongue attached from glossohyal to anterior margin on the median line; considerably free. One premaxillary bone. Vomerine teeth on a ridge, which is continuous between the interior nares. Maxillary teeth* confined to the anterior part of the arch, compressed, knife-shaped, with entire enamel; mandibular teeth of similar form and large development, few in number, and confined to the anterior half of the ramus. Toes 4–5.

This curious genus is furnished with by far the most powerful dentition of any of existing salamanders, and resembles in this respect the genera of the Coal Measures, Brachydectes, Hylerpeton, and Hylonomus. In other points there is little difference between it and Plethodon. One marked feature brings it nearer Desmognathus than any other genus of Plethodontidæ. The exoccipito-proötics are each furnished with a high longitudinal crest, over which the temporal muscle passes from its origin on the atlas. It has, however, the usual origin from the median line of the parietals, which scarcely exists in Desmognathus. This line is marked in *A. lugubris* by an elevated crest. The end of the muzzle in that species bears evidence to a habit similar to that which accompanies the singular structures of Desmognathus, viz, that of burrowing or rooting among stones or other resisting objects. The derm is similarly adherent to the bone, and the latter is exostosed and rugous. The prefrontal bones are well developed.

* Girard, *l. c.*, describes the teeth as not fixed to the jaw, and capable "of a depression backwards." This is only true of successional teeth or teeth about to be shed; the functional teeth are firmly anchylosed.

No species has yet been found east of the Pacific coast region.

α. Distal half of tail rounded or oval.

Large, stout; thumb developed; fingers short; parasphenoid series narrow, vomerines strongly curved backwards; width of head 4–5 to groin; light brown above, with yellow spots ..... *A. lugubris.*

Smaller, slender; thumb not distinct, fingers long, slender; parasphenoid series wider; vomerine series scarcely recurved; width of head 6.33 times in length to groin; above black, sides gray ..... *A. ferreus.*

αα. Distal half of tail strongly compressed.

Robust; muzzle wide; parasphenoid tooth patch wide; digits short, the inner not free; width of head 5–5 times in length to groin; black, sprinkled with small bluish spots above ..... *A. ïëcanus.*

AUTODAX LUGUBRIS Hallow.

(Plate 27, figs. 1–4; 35, fig. 3; 48, fig. 15.)

Anaides lugubris Baird, Iconogr. Encycl., II, 1849, p. 256; Baird & Girard, Proc. Ac. Phila., 1853, p. 302; Baird, U. S. Expl. Exped., Herp., Pl. I, figs. 26–33, and Rept. U. S. Expl. Surv., XIII, p. IV, Pl. 30, fig. 4; Cope, Proc. Ac. Phila., 1869, p. 109: Strauch, Salam., p. 75; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 52.

Salamandra lugubris Hallow., Journ. Ac. Phila., 1848, p. 126.

Taricha ? lugubris Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 26.

Amblystoma punctatum Gray, *ibid.*, p. 37.

The head is elongated, very much depressed, flattened, and when viewed from above is much swollen posteriorly. The snout is very prominent, protruding beyond the lower jaw. The nostrils are elevated, lateral, subterminal, and far apart. The eyes very prominent; their diameter enters only once in the distance between their anterior rim and the extremity of the snout. The cleft of the mouth is large and undulating. The maxillary teeth are proportionally large, especially on the lower jaw. They are lanceolate in shape, very acute and thin. The palatine teeth are inconspicuous, rather blunt, disposed in an open V-shaped figure, the summit of which is directed backward, whilst its branches extend to the internal and posterior margin of the inner nostrils. There are two elongated patches of minute teeth on the parasphenoid, closely approximated anteriorly and diverging slightly posteriorly, where they are rounder and broadest. The cordiform or peltate tongue fills the whole space of the inferior floor of the mouth. It is attached along its medial line, whilst its sides are perfectly free, as is also slightly its tapering tip and its posterior bilobed expansion.

The neck is elongated and slightly contracted; a distinct and well-marked gular fold may be observed. It no doubt exists during life, though its presence has been contested by some writers.

The body is subfusiform, diminishing towards both extremities. The sides of the abdomen are transversely folded thirteen times between axilla and groin. The tail is almost as long as the head and body to-

gether. It is subcylindrical, somewhat compressed, and tapering at the end. Its upper and lower edges are rounded.

The limbs are slender, the posterior ones a little longer and stouter than the anterior. When the former are brought forward and the latter backward alongside the body the toes of either slightly overlap the other. The toes themselves are slender, entirely free, and terminated by a callous, disk-like expansion, resembling in that respect some Anura. The anterior inner toe is quite small; the third is the longest; the second nearly equal in size to the fourth; the second and fourth are nearly equal.

The skin appears quite smooth; when examined under the microscope, however, it is found to contain a net-work of minute irregular stelliform pores, each stella having a hollow or clear center or mouth.

The color, as preserved on specimens in alcohol, is of a uniform light brown above and light yellow beneath. The sides, and frequently the upper surfaces, are marked with small irregular yellow spots.

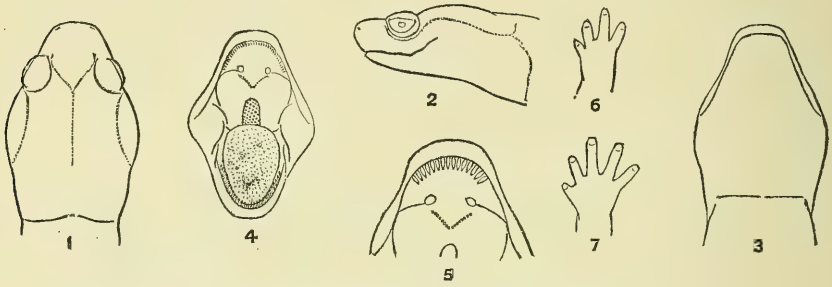

FIG. 44. *Autodax lugubris*. No. 4047. Petaluma, Cal.; ½.

Measurements, in inches.

	Inches.
Length, axial, from snout to orbit	.2
Length, axial, from snout to rictus oris	.5
Length, axial, from snout to axilla	1.18
Length, axial, from snout to groin	2.63
Length, axial, from snout to end of vent	3.13
Length, axial, from snout to end of tail	2.63
Length of fore-limb	.85
Length of hind limb	1
Length of fore-foot	.28
Length of hind foot	.4
Width of hind-foot sole	.33
Width of head at rictus oris	.7
Width of body at middle	.59
Width of body at sacrum	.41

The range of this species is limited, embracing only middle California. It is, however, not rare in that region.

Autodax lugubris Hallow.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4047	10	Petaluma, Cal		E. Samuels	Alcoholic.
4036	5	Farallones, Cal		Lieut. W. P. Trowbridge, U. S. A.	Do.
11424	8	California (?)			Do.
4030	1	San Francisco, Cal		Lieut. W. P. Trowbridge, U. S. A.	Do.
4036	2	do		do	Do.
4021	3	Monterey, Cal		A. S. Taylor	Do.
11576	6	San Francisco, Cal			Do.
4004	6	Petaluma, Cal		E. Samuels	Do.
8677	1	Fort Tejon, Cal	Aug. —, 1875	H. W. Henshaw	Do.
4010	1	San Francisco, Cal		Lieutenant Warren	Do.
13947	3	Berkeley, Cal	1884	R. E. C. Stearns	Do.
13943	1	do	1884	do	Do.
6586	4	Monterey, Cal		Dr. Campfield	Do.
14475	6	California		(?)	Do.

This is one of the most marked species of North American salamanders. The large temporal muscles give the head a swollen outline behind, and separate the derma from the cranium. The latter adheres to the top of the prominent muzzle. The fissure of the mouth is sinuate, most strongly so in adult specimens. On the whole, the physiognomy is not unlike that of the snapping tortoise. I have little doubt that it is more capable of inflicting a bite than any other of the American Urodela. Its food does not appear to differ much from that of other salamanders; in the stomach of one I found ants, in another three or four species of beetles, among them an entire Coccinella.

AUTODAX FERREUS Cope.

Anaides ferreus Cope, Proceed. Ac. Phila., 1869, p. 109; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 53.

This is a smaller and more slender species than the last, not being very different in proportions from *Plethodon intermedius*, but with a broader and more flattened head.

The head is an elongate oval, slightly truncate in front. The nostrils are antero-lateral, and with a delicate groove connecting with the commissure of the mouth. Canthus rostralis not marked. The muzzle is as long as the fissure of the eye, while the length of the commissure of the mouth (diagonal line) is equal to the width of the head at the rictus. The tongue is largely free, the posterior portion rather narrowly. The inner nares are nearer together than the outer. The vomerine teeth commence behind the nares, and form a single series of eight on a ridge, which is gently arched backwards on the median line. The parasphenoid patch does not extend quite forward to the middle of the orbits; it is much flatter and wider anteriorly than in *A. lugubris*, and contains opposite the posterior margin of the orbits ten longitudinal series of teeth, those of adjacent rows alternating.

Gular fold well marked; costal folds fourteen, not continued on back or abdomen. The limbs, and especially the digits, are slender; appressed to the side, they fail to meet by the length of the fingers. The form of the body is slender and cylindric, and the width of the head enters the total length to the groin seven times. The tail is, as in *A. lugubris*, equal to the head and body in length, cylindrical, slender, and slightly compressed at tip.

The thumb possesses a short phalange, but no part of it is free, as in *A. lugubris*; on the other hand, all the phalanges of the other toes of both feet are more slender than the *A. lugubris*, and the distal ones distinctly truncate and slightly emarginate, with dermal thickening below tip. All are quite free. Number of phalanges, 1–2–3–2, 1–2–3–3–2.

Coloration.—Sides and nape greenish-gray; top of head and dorsal region behind in the form of a serrate band, with the tail, black; below yellowish-brown; limbs black above, brown below; inferior regions unspotted.

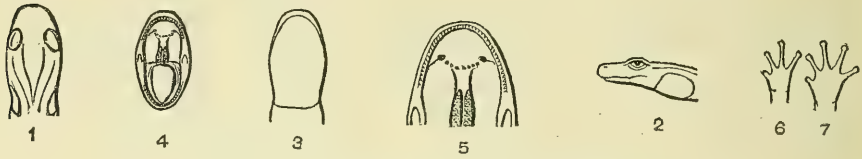

FIG. 45. *Autodax ferreus.* No. 6794. Fort Umpqua; ½, ¾.

Measurements, in inches.

	Inches.
Length, axial, from snout to rictus oris	.42
Length, axial, from snout to axilla	.70
Length, axial, from snout to groin	1.75
Length, axial, from snout to end of vent	2.
Length, axial, from snout to end of tail	3.65
Length of fore-limb	.5
Length of fore-foot	.2
Length of hind limb	.55
Length of hind foot	.26
Width of hind-foot sole	.11
Width of head at rictus oris	.28
Width of body at middle	.24
Width of body at sacrum	.2

The maxillary bone displays the same sudden decurvature anterior to and below the orbit which the *A. lugubris* does, but it is less marked; in consequence, the commissure of the mouth is less sinuate. The long mandibular and maxillary teeth, while of similar structure, are less developed. Perhaps larger specimens of this species may be found where they may be larger, as in small specimens of *A. lugubris* they are nearly similar in proportions.

Though nearly allied to the *A. lugubris*, the present species will never be confounded with it. It is a much weaker form, and does not display the characters of the genus in so striking a degree. The form of the

tail is that of *A. lugubris*, and not that of *A. iëcanus*. But one specimen has come under my observation, as follows:

No. 6794; 1 specimen; Fort Umpqua, Oregon; Dr. Vollen.

AUTODAX IËCANUS Cope.

Plethodon iëcanus Cope, Proceed. Ac. Phila. 1883, p. 24.
Anaides iëcanus Cope, Proceed. Amer. Philosoph. Soc., 1886, p. 526.

A fully grown individual of this species presents the following characters: The form is rather robust, and the head is distinguished from the neck by the swollen temporal muscles. The muzzle is short and wide, with rounded border, and is not so contracted as in the *A. lugubris*. The length from the end of the muzzle to the axilla enters that from the latter to the groin one and a half times. The tail is of moderate length, equaling that of the body (including vent) nearly to the thoracic fold. The width of the head enters the length from end of muzzle to groin five and one-half times—a proportion intermediate between those exhibited by the two other species of the genus. The limbs are rather robust, and when appressed to the sides leave an interval of three intercostal spaces.

The top of the head is flat, and the least interorbital width is equal to the length from the eye to the end of the muzzle and to the space inclosed between the external borders of the external nares. The commissure of the mouth rises behind the line of the orbit as in the *A. lugubris*. The muzzle does not project beyond the mouth, as it does in *A. lugubris*. The internal nares are very small. The tongue is large and antero-posteriorly oval, and is extensively free at the sides. The vomero palatine teeth are in two short rows of three or four teeth each, which commence behind the internal nares, on a line with their internal borders, and converge, with slight posterior inclination, without meeting. The patch of parasphenoid teeth is wide and subtruncate in front, and is undivided except towards the posterior portion. The large teeth of the jaws are not so well developed as in the *A. lugubris*, are more slender in form, and not so numerous. They constitute the entire armature of the dentary bone, occupying only the anterior half. I count only four of them, and they are movable; that is, immature. I find no fixed ones of the larger size in the upper jaw. Three or four of the posterior maxillary teeth are like those of the dentary bone, but they graduate anteriorly into teeth of the usual type. An examination of other specimens will be necessary to ascertain whether these teeth become permanent or not, or whether they are developments of the breeding season. The large temporal muscles, curved commissure of the mouth, etc., so resemble the corresponding parts in the *A. lugubris*, that I suppose their permanent dental characters to be alike. The maxillary bone projects abruptly downwards behind the last maxillary tooth, forming a smooth edge, as in *A. lugubris*.

The skin of the *A. iëcanus* is smooth. There are thirteen lateral folds between axilla and groin, and a strong pectoro-gular fold. The latter rises on each side in front of the shoulder, and then turns upwards and forwards. It is soon changed into a narrow dermal ridge or rib, which is first convex upwards and then convex downwards, and then terminates in line with the eye a diameter of the latter behind it.

The feet are short, and the digits are flattened and are obtuse at the tips. The pollex is only free by a slight notch, and the hallux by a rather deeper one. The phalanges are: Anterior, 1–2–3–2; posterior, 1–2–3–3–2. The third and fifth anterior digits are equal, while the posteriors run 1–2–5–3–4, beginning with the shortest. The third and fourth are nearly equal.

The tail is somewhat depressed at the base, and becomes round in section to the end of the proximal two-fifths. It then becomes gradually more compressed, until it is quite flat for the distal third.

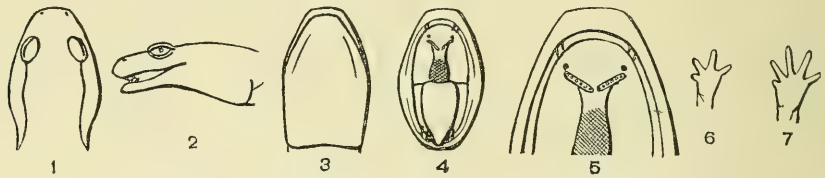

FIG. 46. *Autodax iëcanus*. No. 14596. Shasta County, California; ½.

The color is black, relieved by a yellowish-brown shade of the chin, and of the palms and soles, and half the inferior side of the fore-arm. A line of the same color passes from the nostril to the upper lip, and the lower eyelid has the same color. The superior surfaces and sides of the head, body, and tail are dusted rather thickly with small subequal bluish-white spots, much as are seen in *Plethodon glutinosus*.

Measurements of No. 14,596.

	M.
Length from end of muzzle to end of tail	.122
Length from end of muzzle to end of vent	.071
Length from end of muzzle to groin	.059
Length from end of muzzle to axilla	.023
Length from end of muzzle to canthus oris	.010
Length of fore limb	.015
Length of hind limb	.017
Length of hind foot	.008
Width between orbits (least)	.0036
Width of head (greatest)	.011

The typical adult specimen displays the anomaly of the suppression of the fourth posterior digit of the left side.

This salamander resembles the *Plethodon glutinosus* in various respects, especially in coloration. It has, however, a compressed tail, like the *P. intermedius*, and short series of vomerine teeth. The recurved commissure of the mouth gives it the smiling expression characteristic

of the other species of Autodox, which is quite different from that seen in Plethodon.

The *Autodax iëcanus* was originally established on a half-grown specimen found by myself in Shasta County, Cal. A second specimen of the same size was sent to the National Museum by Mr. Charles Townsend from the same locality. The young specimens do not display the physiognomy of the genus, but have the usual want of character as compared with the adult. The vomerine series of teeth are, however, rather better developed. The typical specimen has the following characters:

The vomerine series are straight, and do not quite meet on the middle line. They are entirely behind the nares, and do not extend exterior to them. The parasphenoid patches are united into one, and are well separated from the vomerines.

Form rather stout, and the tail short, equaling (from vent) the length of the body (with vent) to the gular fold. Costal folds, 13. Head a longitudinal oval, with rather narrowed and not truncate muzzle; its length (to occiput) contained $3\frac{2}{3}$ times in length from muzzle to groin.

Limbs short; when pressed along the side they are separated by three intercostal spaces. The digits are short and the internal ones are rudimental.

The color is black everywhere, and the superior surfaces are dusted over with minute light specks.

Measurements.

	M.
Total length	.053
Length from muzzle to axilla	.0105
Length from muzzle to groin	.0275
Width of head at canthus oris	.006
Length of anterior limb	.005
Length of anterior foot	.002
Length of posterior limb	.0075
Length of posterior foot	.0032

This species is to be compared with the *Plethedon intermedius* of western Oregon. It is shorter and more robust in form, having only thirteen costal plicæ instead of fifteen. The color is very different.

Cat. No.	No. spec.	Locality.	Collector.
13791	1	Baird, Shasta County, Cal	C. H. Townsend.
14596	1	do	Livingston Stone.

This species is named from the aboriginal name Iëka, of the grand peak of northern California, Mount Shasta. From the same name the town of Yreka derives its name. So I am informed by Judge Roseborough, of that place, to whom I am under great obligations for many facilities and much information.

DESMOGNATHIDÆ.

Cope, Journ. Ac. Nat. Sci. Phila., 1866, 107.

Pterygoids wanting. Orbitosphenoid separated by membrane from proötic. Vestibule, internal wall osseous. Dentigerous plates on the parasphenoid. Ceratohyal articulating with quadrate. Carpus and tarsus cartilaginous. Vertebræ opisthocœlous. Hyoid apparatus as in the Plethodontidæ.

The peculiarity of the vertebræ distinguishes this family chiefly from the last. In the only genus which represents it, there are numerous peculiarities, which are not found elsewhere. Should other genera be found which do not possess them, the above diagnosis would probably be the proper test of their family affinities.

The distribution is confined to the eastern district of the nearctic realm so far as yet known.

The Thoriidæ only differ from the Desmognathidæ in the osseous carpus and tarsus. The single genus Thorius Cope is included by Boulenger in the Desmognathidæ. Thorius has a boletoid tongue like Spelerpes, and the parietal region mostly membranous. Toes, 4–5. One species, *T. pennatulus* Cope, of small size, from E. Mexico.

DESMOGNATHUS Baird.

Journ. Ac. Nat. Sci., I. 282,285; Gray, Cat. Brit. Mus., 1850, 40; Cope, Proceed. Ac. Phila., 1869 112; Strauch, Salam., p. 72; Boulenger, Cat. Batr. Sal. Brit. Mus. ed. II, 1882, p. 77.

Premaxillaries united, embracing a fontanelle; parietal bones ossified. Prefrontal bones wanting. Occipital condyles on cylindric pedestals. Temporal muscle arising only from the atlas, with a tendinous external margin and insertion, passing freely over the parietal and proötic bones. Tongue attached, except by its lateral and posterior margins. Vomerine and sphenoidal teeth present. Digits distinct, 4–5.

The absence of o. prefrontale does not appear to be the result of its confluence at any late period with the nasale; its ordinary position is traversed by the frontal suture. The frontal bone is decurved, and closes the preorbital aspect of the superpalatal vacuity, usually open.

This marked genus, so abundantly represented by individuals in the eastern district of North America, is not admitted by either Duméril or Hallowell, probably because it does not differ in external characters from Plethodon. It is an excellent illustration of the error of adhering to external characters only, in the explanation of the relations and affinities of organized beings, except for a limited range. The examination of the skeleton of species of this genus utterly changes the impressions produced by a consideration of the external characters. It may be stated as characteristic of the Batrachia in general that their affinities can not be determined without study of the skeleton.

There are no dermal appendages developed in this genus at the breeding season.

I. Males with posterior half of the mandible concave and edentulous.
Inferior lateral series of pores imperfect or wanting, superior none; no tubercle in canthus oculi; tail mostly rounded; fourteen costal plicæ; a yellowish dorsal band; belly immaculate; size small ..... *D. ochrophæa.*

II. Males with mandibular alveolar margin continuous and completely toothed.
Inferior lateral series of pores well developed, superior irregular or wanting; a tubercle in canthus oculi; tail compressed, keeled, and finned; fourteen costal plicæ; above dark spotted, below marbled; size medium ..... *D. fusca.*
Two well-developed lateral series of pores; a marked tubercle in the canthus of the eye; tail flattened, finned above, attenuate; twelve costal folds; black above and below; size large ..... *D. nigra.*

DESMOGNATHUS OCHROPHÆA Cope.

Proceed. Ac. Nat. Sci. Phila., 1859, 122.

This small species bears a strong resemblance to the *Spelerpes bilineatus* Green, and, apart from generic characters, may be known from it by the rounded tail, the paler-colored abdomen, and the light bar from the eye to the angle of the mouth. Its proportions are stouter than in *Plethodon cinereus erythronotus*, to which it also bears some resemblance.

The costal folds are thirteen, but fourteen if that which is immediately above the groin be counted. The first falls immediately into the axilla. This is the characteristic arrangement in *D. fusca* also, while in *D. nigra* the fold above the groin usually extends to it, and is the twelfth, while that which corresponds to the first of the species before named falls just in advance of the axilla. Though this is typical of *D. nigra* occasionally another plica appears above the groin, and the twelfth is slightly in front of it.

The pores in *D. ochrophæa* are very difficult to observe. In a few specimens I have seen a few of those of the lower series; the upper I believe to be wanting. The gular fold is distinct, and another vertical fold commences behind its extremity, and turning longitudinally, extends more or less distinctly to the orbit. As in other species, the derm adheres closely to the frontal bones and is more or less rugulose. The head is oval, with rounded depressed muzzle; its greatest width enters the length to the groin $5\frac{2}{3}$ times. The commissure of the mouth is slightly flexuose.

The appressed limbs fail to meet by four intercostal spaces. The inner digits of both feet are short but free, longer than in Plethodon species of similar size; the other digits are also longer and more distinct; proportions, 1–4–2–3, 1–5–2–4–3; only three phalanges in longest toes. The tail is quite slender, and only compressed at tip; in some there is a keel above on the distal third, but never any dermal fin.

The vomerine teeth are very few and small when present; they are often wanting. Their basal line is on a ridge, which is convex back-

wards, nearly continuous medially. The parasphenoid teeth stand on two narrow plates, which are well separated, especially behind, and are shortened; anteriorly they only reach to near the middle of the orbits. The mandibular teeth present pecularities in the male, by which it may be readily distinguished from the female. In a large number of specimens the oral commissure is but little undulate, and the mandibular teeth though longer medially, are continued to near the basis of the coronoid process. The males exhibit a strongly flexuous commissure, and the alveolar margin of the mandible is deeply concave below the front of the orbit, and is edentulous. The distal portion is abruptly convex and is armed with long teeth. The margin is slightly concave anterior to this point, and finally rises again at the symphysis, which is prominent and protected externally by a pad of crypts as in *D. fuscus*. The structure of the males is in the mandibular dentition quite that of the genus Autodax; the *A. ferreus* presenting the characters but little more strongly. No such sexual difference can be found in the *D. fusca*, though the commissure only may be sometimes more flexuous in males. The jaws and dentition in the *D. nigra* do not differ in the two sexes. I have observed that two of the many males of *D. ochrophœa* possess the female denition. The tongue in *D. ochrophœa* is an elongate oval, considerably free behind.

The color of females is a bright brownish yellow, fading to dirty white below, with a dark brown shade on each side from the eye to the end of the tail, which is darkest above and gives the dorsal space the character of a band. There is an irregular series of brown dots along the vertebral line. Males are rather larger and usually darker in color; thus the dorsal band is brownish, the lateral band blackish, and the dorsal spots more distinct. In most specimens of both sexes there is a light band from the eye to the rictus oris, and the belly is always immaculate; the gular region nearly always. The testes and vas deferens are covered with black pigment; no pigment on the peritonæum of the female.

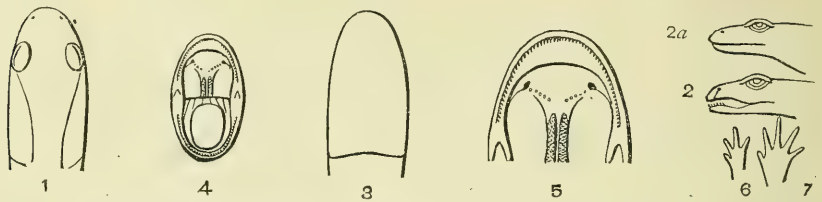

FIG. 47. *Desmognathus ochrophœa*. No. 6891. Meadville, Pa.; $\frac{3}{2}$, $\frac{3}{1}$. Fig. 2, ♂; 2*a*, ♀.

This species attains scarcely half the size of the *D. fusca*, as indicated by the numerous females with developed eggs in our collections. As the eggs are equal in size to those of *D. fusca* when ready to be discharged, and as the species is only half the size of the same, the eggs in the oviduct of a gravid female at one time are only half as numerous. I have only found from 6 to 10 in *D. ochrophœa*, in each oviduct, while from 18 to 30 may be counted on one side in *D. fusca*.

Measurements of No. 6891, in inches.

	Inches
Length, axial, from snout to rictus oris	.2
Length, axial, from snout to axilla	.46
Length, axial, from snout to groin	1.29
Length, axial, from snout to end of vent	1.51
Length, axial, from snout to end of tail	3.01
Length of fore limb	.3
Length of fore foot	.08
Length of hind limb	.36
Length of hind foot	.17
Width of hind-foot sole	.8
Width of head at rictus oris	.2
Width of body at middle	.22

Habitat, etc. This salamander is chiefly abundant in the chain of the Alleghanies and their outlying spurs. I have never seen it in the hill country of Pennsylvania or the lower plains of New Jersey and Maryland, nor have I observed it in the Alleghanies of southwestern Virginia. I have taken it abundantly in the Black Moutains of North Carolina. The Philadelphia Academy possesses numerous specimens from the Broad-Top Mountain, in southern Pennsylvania, from Dr. Leidy. It has others from Warren County, Pa., from Dr. Randall. In northern Pennsylvania and the Adirondacks it is very abundant.

The habits of this animal are terrestrial. It occurs under the bark of every fallen log of hemlock (*Abies canadensis*) and in the débris of the dark damp forests of the North. I never saw one in the water of streams and river banks, the habitat of the other species of the genus.

Professor Baird was familiar with this species before I described it. I published his suggestion, expressed in a letter, that it was the *S. haldemani* of Holbrook. Holbrook's figure does not represent this species in any degree, nor is his description more conclusive as to the reference of this species to it rather than some others. He says it is marked with spots on the upper surfaces, which are "disposed without much regularity," but the largest are on the flanks. There are but few spots above in this animal, and they are in a regular median series. The sides are banded. He also describes and figures the belly as yellow, which it is not in *Desmognathus ochrophæa*. The *Salamandra haldemani* appears to me to have been proposed on an unusually spotted *Spelerpes bilineatus*.

Desmognathus ochrophæa Cope.

Catalogue number.	No. of spec.	Locality.	Whence and how obtained.
3917	10	Allegany County, N. Y	Dr. Stevens.
4041	3	Bradford County, Pa	C. C. Martin.
	20	Meadville, Pa	Professor Williams.
4539	5	Susquehanna County, Pa	Professor Cope.

Variety. A specimen with the dentition, coloration, and proportions of body and tail of this species was sent to the Smithsonian Institution from northern Georgia by Dr. Jones. It approaches the *D. fusca* in having a small *tuberculum canthus oculi*, and a well-developed inferior series of mucous pores.

DESMOGNATHUS FUSCA Raf.

(Plates 34, figs. 5, 6; 36, fig. 1; 45, fig. 7.)

(var. *fusca.*)

Baird, Journ. Ac. Phila. (2), I. p. 285; Cope, Proceed. Ac. Phila., I, 1869, p. 115; Strauch, Salam., p. 74; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 40; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 77.

Triturus fuscus Rafin., Annals of Nature, 1820 (*fide* Baird).
Salamandra intermixta Green, Cont. Macl. Lyc. I, p. 827.
Salamandra picta Harlan, Journ. Ac. Phila., V, p. 138.
Salamandra quadrimaculata Holbr., N. A. Herp. V, p. 49, Pl. 12.
Plethodon fuscum Dum. & Bibr., p. 85, Pl. 101, fig. 3.
Plethodon niger Hallow., pt., Journ. Ac. Phila. (II), 1858, p. 344. et var. *auriculata.*
Salamandra auriculata Holbr., N. A. Herp., V, p. 47, Pl. 12.
Desmognathus auriculatus Baird, Journ. Ac. Phila. (2), I, p. 286; Strauch, Salam., p. 74; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 41.
Cylindrosoma auriculatum Dum. & Bibr., p. 81.
Desmognathus fusca var. *auriculata* Cope Proc. Ac. Phila., 1869 ,p. 116; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. III, 1882, p. 78.

This, perhaps the most abundant salamander in North America, is quite variable in coloration, but not in proportions and structural peculiarities. Those of the latter which characterize it are the presence of fourteen costal plicæ; one well, and one little developed lateral series of mucous pores; the equal and regular distribution of teeth on the mandible of males; the compressed tail keeled above and finned distally; the presence of a tubercle in the anterior canthus of the eye; the marbled color of the belly. In many quarts of specimens I find four specimens from southern localities; two in the Philadelphia Academy from Charleston, two in the Smithsonian from Biloxi, Miss., which have fifteen plicæ, but one of the latter has fourteen on one side. In specimens which have been preserved in too strong spirit the pores are rendered invisible; the same occurs when the spirit is impure or weak. In soft specimens, the canthal tubercle sometimes disappears, and in many young specimens and some adult females it does not appear to exist.

The head is more depressed and the muzzle prolonged than in species of other genera. The eyes are prominent; the plicæ behind them strongly marked. These consist of one on each side the head and nape, which converge posteriorly and then turn abruptly outward, to be continued into the gular plica. A second plica extends from the mandible across the rictus oris to the upper plica. A second longitudinal

plica extends from this to the gular, inclosing an ovate enlarged area, and a short one to the orbit incloses a postorbital subround and smaller area.

The commissure of the mouth is more undulate in males than in females, but both present a slight elongation of the symphysis, produced externally by a pad of crypts. The width of the head enters the length 5.66 times. The vomerine teeth are often wanting, and when present are minute and few. Their basis is a ridge, which extends from behind the middle of the posterior nares across the palate with a posterior convexity. The parasphenoid patches are small and not in contact; they do not extend to opposite the middle of the orbits.

The median toes are elongate, and as in *D. ochrophæa*; they fail to meet by four interspaces when pressed to the side. The tail has a characteristic form, which is invariable at all periods; near the base the section is trigonal; the dorsal keel increases in elevation and becomes a narrow fin posteriorly; the extremity is attenuated. Its length is just equal to that of the remainder of the animal.

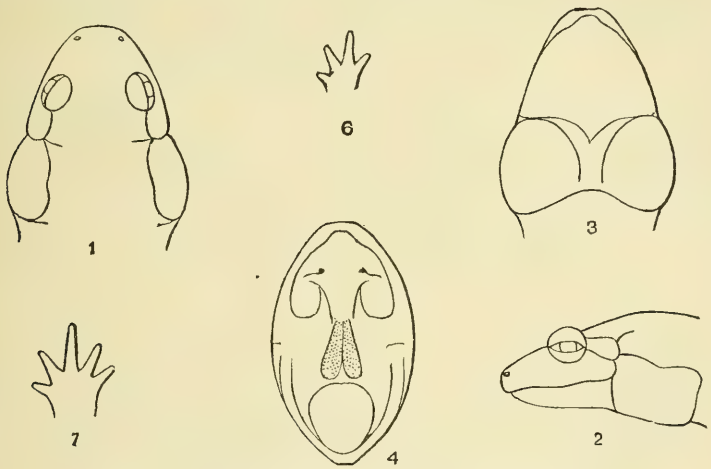

FIG. 48. *Desmognathus fusca fusca.* No. 40. Carlisle, Pa.; ⅔.

There are two color varieties, which blend together so as to indicate that no higher value can be attached to them; one of these is the *Salamandra auriculata* of Holbrook.

Above brown, with gray and pink shades; sides and belly marbled, the pale predominating; no red spots on sides ..... var. *fusca.*

Above and sides black; the latter with a series of small red spots; a red spot from eye to canthus of mouth, present or absent; belly marbled, the dark predominating ..... var. *auriculata.*

The latter variety occurs only in the Southern States; the tubercle of the angle of the eye and the upper lateral pores are often better developed in it than in var. Fusca, therefore approaching *D. nigra.* It is, however, easily distinguished from the latter. Sundry specimens

lack the red spots, and others have paler bellies, resembling thus the darker Fuscæ. The size is the same.

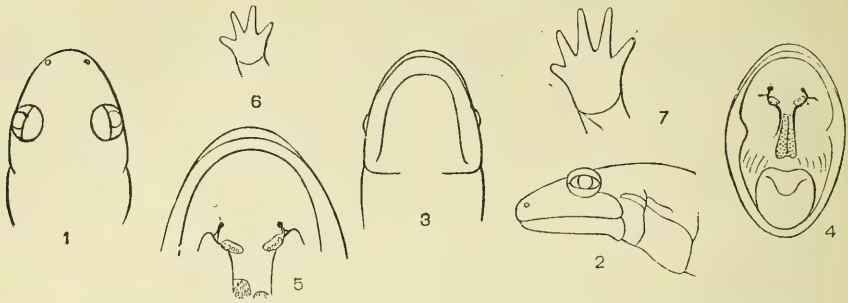

FIG. 49. *Desmognathus fusca auriculata*. No. —.; ⅔.

In the young of *D. fusca* there is a series of pinkish incompletely separated alternating spots, in two series, covering the whole dorsal region; they are rarely so well distinguished or so bright as in the specimen of the same which furnished the type of Holbrook's *S. quadrimaculata*. The pink fades to orange brown or ocher, and to pale brown, with age, and at the fullest maturity all are lost in a uniform blackish

Measurements of No. 6832, in inches.

	Inches.
Length axial, from snout to rictus oris	.3
Length, axial, from snout to axilla	.71
Length, axial, from snout to groin	1.95
Length, axial, from snout to end of vent	2.3
Length, axial, from snout to end of tail	4.6
Length of fore limb	.42
Length of fore foot	.15
Length of hind limb	.62
Length of hind foot	.26
Width of sole foot	.16
Width of head at rictus oris	.375
Width of body at middle	.55

Habitat, etc.—This species lives chiefly among the stones in the many shallow rivulets and springs of the hilly and mountainous regions of the country. It is not so partial to deeper and stiller waters as the *Spelerpes ruber*, but prefers the rapid and shallow streamlets; here it may be found under every stone, or its delicate larva may be observed darting rapidly from place to place, seeking concealment among mud and leaves. The *D. fusca* is one of the most active and vigorous of our species. The peculiar structure of the temporal muscle and its tendons, and of the occipital condyles, with the strength of the bones of the front, enable it to burrow among stones and in earth more readily than the species of other genera. When pursued, it runs and wriggles out of sight with the greatest rapidity, and is quickly concealed by assistance of its dusky colors.

Professor Baird originally noticed the curious disposition of the eggs in this species, which I have verified on a few occasions. As in the

anurous genus Alytes, the eggs, on emission, are connected by an albuminous thread, which soon contracts and hardens. One of the sexes protects this rosary by wrapping it several times round the body and remaining concealed in a comparatively dry spot. How long this guard continues is not known.

The most Eastern specimen I have seen is from Essex County, Mass. Besides a great number of specimens in the Museum of the Philadelphia Academy, the following form the Smithsonian basis of the examination:

Desmognathus fusca fusca Rafinesque.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
7901	26	Carlisle, Pa		Prof. S. F. Baird	Alcoholic.
8874	1	Mandeville, La	Nov.—, 1878	N. O. Academy	Do.
8332	8	Kinston, N. C		Welsher & Milner	Do.
3983	10	Meadville, Pa		Professor Williams	Do.
3916	10	Carlisle, Pa		Prof. S. F. Baird	Do.
3909	5	Salem, N. C		J. T. Lineback	Do.
11899	2	Nashville, Ga	Aug. 5, 1880	W. J. Taylor	Do.
3904	10	Abbeville, S. C		Prof. S. F. Baird	Do.
3915	15	Westport, N. Y		do	Do.
8823	1	Tennessee	1876	J. N. B. Scarborough	Do.
8829	1	Claiborne County, Tenn		do	Do.
3896	14	Columbus, Ohio		Prof. L. Lesquereux	Do.
3882	6	Orange, N. J		Dr. J. G. Cooper	Do.
3883	5	Pittsburgh, Pa			Do.
3914	3	Highland County, Ohio			Do.
3908	3	Eutaw, Ala			
3891	5	Mississippi		Col. B. L. C. Wailes	
3769	3	Philadelphia, Pa	1851	J. Richard	Do.
11542	1	Rock Creek, D. C		P. L. Jouy	Laiva.
4843	1	Brookville, Ind		Dr. R. Haymond	Do.
3912	4	Adirondack, N. Y		R. Clarke	Do.
9301	2	Norfolk, Conn	1877	A. F. Wooster	Do.
14477	2	Gloucester, Md		(?)	Do.
3925	3	Gloucester, Va		(?)	Do.
3901	10	Riceborough, Ga		Dr W. L. Jones	Do.
6831	2	Biloxi, Miss		C. Billman	Do.

GENERAL SERIES.

3909	4	Salem, N. C			Alcoholic.
3914	2	Highland County, Ohio			Do.
3883	20	Meadville, Pa		Williams	Do.
8802	1	Augusta, Ga		Wm. Phillips	Do.
6884	2	(?)		(?)	Do.
8828	2	Franklin County, Tenn		J. N. B. Scarborough	Do.
13317	1	Washington, D. C		(?)	Do.
8809	16	Columbia, S. C		Dr. Geo. A. Moran, U. S. A	Do.
7830	27	Washington, D. C		Dr. E. Coues	Do.
3892	3	Clarke County, Va		C. B. R. Kennerly	Do.
3919	1	Salem, N. C		J. T. Lineback	Do.
3880	6	Anderson, S. C		Miss Paine	Do.
6830	2	Georgia		(?)	Do.
8831	2	Cincinnati, Ohio		J. N. B. Scarborough	Do.
3784	1	Charleston, S. C		(?)	Do.
14446	1	Wytheville, Va	1885	Col. M. McDonald	Do.
7901	120	Carlisle, Pa		Prof. S. F. Baird	Do.
3916	75	do		do	Do.
3763	1	Mississippi		Dr. Shumnard	Do.
3921	1	Dayton, Ala		Edgeworth	Do.
8845	1	Fauquier County, Va		C. W. Sheurmann	Do.
3876	2	Summerville, N. C		J. McNair	Do.
3678	2	do		(?)	Do.
3910	4	Knoxville, Tenn		Prof. J. B. Mitchell	Do.
3905	1	Columbia County, Pa		Dr. Henderson	Do.
4718	2	Georgia		Dr. W. L. Jones	Do.
5039	1	do		do	Do.
4717	2	do		do	Do.
6830	5	do		do	Do.
6832	4	do		do	Do.

Desmognathus fusca auriculata Holbrook.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8906	8	Oakley, S. C	April 5, 1877	F. W. Hayward	Alcoholic.
8819	10	Cincinnati, Ohio		J. N. B. Scarborough	Do.
3901	1	Riceborough, Ga		Dr. W. L. Jones	Do.
6836	5	(?)		(?)	Do.
3866	3	Knoxville, Tenn		Prof. J. B. Mitchell	Do.

DESMOGNATHUS NIGRA Green.*

Baird, Journ. Acad. Phila. (2) I, p. 286; Cope, Proceed. Ac., Phila., 1869, p. 117; Strauch, Salam., p. 73; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 40; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 79.

Salamandra nigra Green, Journ. Ac. Phila, I, p. 352.
Triton niger Holbr., N. A. Herp., and p. 81, Pl. 27.
Amblystoma nigrum Dum. & Bibr., p. 105.
Plethodon niger Hallow., Jour. Ac. Phila. (2), III, p. 344, partim.

This is the most robust salamander of the eastern regions of our zoological realm; it is not so slender as the *Gyrinophilus porphyriticus*, and is a much stronger animal. As compared with the *D. fusca* it is much larger, the tail is more compressed and extensively finned, and the color is uniformly different. Besides the characters already pointed out in the table, it differs from *D. fusca* as follows: The parasphenoid patches of teeth are prolonged more anteriorly, and approach very near the vomerines in most instances; they are always prolonged beyond the middle of the orbits; their prolongation is at the same time narrowed, and in most the patches are not distinguished at this point. The vomerine series are better distinguished (though not always), being oblique, separate, and not extending beyond nares. The tongue is in eight specimens examined nearly round, while it is always a long oval in the two other Desmognathi; finally, the only male does not possess the black pigment coat of the testes always present in the others, though, as in them, the vas deferens is black. The body is stouter, and the width of the head enters the length to the groin less than five times—in the others always more; this is also expressed by the existence of only twelve costal plicæ, and the fact that the appressed limbs are only separated by 2½ intercostal spaces.

The postorbital plicæ are not strongly marked. The mucous pores are well developed, and the two lateral series are often distinct in alcoholic specimens by their white color; when they become dry they are difficult to observe. There are two rather distant gular series within the mandibular rami on each side, and one on each side extending inwards and forwards from the gular plica. The superior lateral series extends from the orbit to near the end of the tail; the inferior round the humeri to each side the pectoral region.

* Plate 49, fig. 1.

The proportions of the fingers are as in *D. fusca;* they are entirely free. The eyes are prominent, with thick opaque palpebrae. A tubercle occupies the anterior angle, which, after an examination of that in *D. fusca*, is proven to be a dismemberment of the superior eyelid.

The coloration is uniform in about twenty specimens examined. It is simple, viz: Uniform black above and below, except the muzzle from between the eyes, the lower jaw, the end of the tail, and the soles of the feet, which are brown.

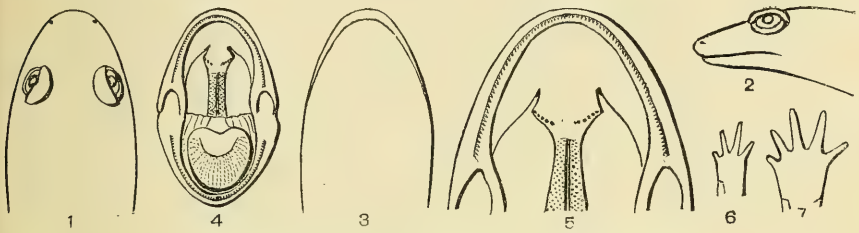

FIG. 50. *Desmognathus nigra.* No. 3923. Abbeville, S. C.; $\frac{1}{1}$, $\frac{2}{1}$.

Measurements of No. 3923, *in inches.*

	Inches.
Length, axial, from end of muzzle to orbit	.29
Length, axial, from end of muzzle to canthus oris	.55
Length, axial, from end of muzzle to axilla	1.22
Length, axial, from end of muzzle to groin	3.23
Length, axial, from end of muzzle to end of vent	3.76
Length, axial, from end of muzzle to end of tail	6.96
Length of fore limb	.69
Length of fore foot	.26
Length of hind limb	1.02
Length of hind foot	.47
Width of hind-foot sole	.27
Width between eyes in front	.30
Width at canthus oris	.65
Width of body	.75
Width of body at sacrum	.54

Habits, etc.—This creature is aquatic; but after the fashion of the *D. fusca* it occurs only in shallow stony brooks. It is, so far as known, confined to the Alleghany mountain ranges from Pennsylvania southwards. It is abundant in the streams of the rocky ravines and cold springs in the remotest depths of the forest, where its retreat is cool and dark. It seeks concealment under loose stones and slabs of slate with great activity, and is not easily caught. Its habitat does not seem to be shared by any species but the *D. fusca;* the *Gyrinophilus porphyriticus*, the other characteristic Alleghany species, haunting standing springs and bogs, where stones are not so numerous. Green described it from Pennsylvania, but Baird, who is familiar with the Alleghany fauna of our State, says he has not observed it near Carlisle; nor have I met with it north of Virginia, where it is common. Besides Green's

type and specimens from near the Kanawha River, in southwestern Virginia, in the Philadelphia Academy Museum, the Smithsonian contains the following:

Desmognathus nigra Green.

Catalogue number.	Number of spec.	Locality.	Whence and how obtained.
3886	2	Georgia	Dr. W. L. Jones.
3923	4	Abbeville, S. C	Dr. J. B. Barratt.
	2	Giles County, Va	E. D. Cope.
14419	1	Wythe County, Va	Col. M. McDonald.

SALAMANDRIDÆ.*

Gray Proceed. Zool. Soc. London, 1858, p. 142. Cope, Journ. Ac. Phil., 1866, p. 107.

No ethmoid bone. Palatines with posterior separate processes extending over the parasphenoid, bearing teeth on their inner margins. Prefrontals and pterygoids present. Parietal entirely separated from prefrontals by broad frontals. Orbitosphenoid confluent with proötic. No dentigerous plates on the parasphenoid. No postfronto squamosal arch. The ceratohyal free, connected with the quadrate by ligament. Carpus and tarsus osseous. Vertebræ opisthocœlous. No otoglossal cartilage.

The hyoid apparatus in this family is like that of the Plethodontidæ. There is a hypohyal on each side of the anterior extremity of the basibranchial which does not articulate with the ceratohyal. In Triturus, Salamandra, and Hemisalamandra, it is short (Plate 36, fig. 8); while in Chioglossa it is recurved posteriorly, passing under the ceratohyal of each side, and almost reaching the basibranchial again near the point of origin of the ceratobranchial (Plate 36, fig. 9). It thus forms a nearly complete circle, supporting the circumference of the tongue. This circle has the same function as that in Amblystoma, but is of different homological value. Appropriately to this functional resemblance to the American forms, the proximate extremity of the ceratohyal is attached to the distal extremity of the suspensorium, but by ligament. In Hemisalamandra, on the other hand, it is attached to the *proximal* part of the same by ligament, thus furnishing a condition intermediate between the types of Chioglossa and of Diemyctylus.

This family is confined to the Old World. It embraces the following genera:

I. Maxillary and pterygoid bones separate, the former not reaching quadrate.
  a. No ligamentous postfronto-squamosal arch.
    Tongue large, free, except on the anterior half of the median line; teeth in two longitudinal curved series ..... *Chioglossa.*
    Tongue large, scarcely free at edges; teeth in two longitudinal curved series ..... *Salamandra.*
    Tongue small, not free; teeth in two straight parallel series .. *Hemisalamandra.*

* Plate 37.

αα. A ligamentous postfronto-squamosal arch.
Tongue small; vomeropalatine teeth in longitudinal series, which converge and join anteriorly, forming a Λ ..... *Triturus.*

II. Pterygoid united broadly with maxillary bone.
Postfronto-squamosal arch partly ligamentous; tongue little free; teeth forming a Λ ..... *Pachytriton*

The species of this family recorded in Boulenger's Catalogue of the British Museum are the following:

Chioglossa lusitanica Bocage, Portugal, and northwest Spain; *Salamandra maculosa* L., central and southern Europe, Algiers, Syria; *S. atra*, Laur., the Alps, 2,500 to 12,000 feet; *S. caucasica* Waga, Caucasus; *Hemisalamandra cristata* Laur., Europe; *Triturus blasii* De l'Isle, northwest France; *T. marmoratus* Latr., France, Spain, Portugal; *T. alpestris* Laur., central Europe; *T. vulgaris* Linn., Europe, except southern France, Spain, and Portugal; temperate Asia; *T. crocatus* Cope, Syria; *T. montanus* Savi, Corsica; *Pachytriton brevipes* Sauvage, South Kiansi, China.

PLEURODELIDÆ.

Cope, Journ. Acad. Phila., 1838, p. 108.

Pleurodelidæ and *Siranotidæ* Gray, Proceed. Zool. Soc. London, 1858, p. 142.

No ethmoid bone. Vomeropalatine bones, with posterior separate processes, extending over the parasphenoid, and having teeth on their inner margins. Prefrontals and pterygoids present. Parietals not embracing the broad frontals. No dentigerous plates on the parasphenoid bone. An osseous postfronto-squamosal arch. Ceratohyal free, connected with quadrate by ligament. Carpus and tarsas osseous. Vertebræ opisthocœlous. No otoglossal cartilage. (Plate 34, figs. 2–7).

This family differs from the Salamandridæ only in its post frontosquamosal arch. Rudiments of it already appear in some members of the latter.

The genera of this family are all found in the Old World. One of them is represented by two species in North America. They are distinguished as follows:

I. Maxillary bone not reaching quadrate.
α. Ribs not perforating the skin.
Toes, 4 ..... *Salamandrina.**
Toes, 5 ..... *Diëmyctylus.*
αα. Ribs perforating the skin; vomeropalatine teeth in a Λ.
Toes 5 ..... *Pleurodeles.*

II. Maxillary bone reaching quadrate.
Toes 5 ..... *Glossolega.*†

The species of the above genera are as follows: *Salamandrina perspicillata* Savi, Italy; *Diemyctylus vittatus* Gray, Asia Minor, Syria; *D. palmatus* Schneid., central and western Europe; *D. montandonii* Boul., Moldavia; *D. boscæ* Lataste, Spain, Portugal; *D. pyrrhogaster*

* *Seiranota* Barnes. † *Tylotriton* Anders.

Boie, Japan, China; *D. sinensis* Gray, China, *D. torosus* Esch., California, Oregon; *D. viridescens* Raf., North America, eastern and austroriparian regions; *D. rusconii* Géné, Sardinia; *D. asper* Dugés, Pyrenees, Spain; *Pleurodeles waltli* Michah., Spain and Portugal, Tangiers; *Glossolega poireti* Gervais, Algiers; *G. hagenmuelleri* Lataste, Algiers; *G. verrucosa* Anderson, Eastern Himalayas, Yunnan.

DIËMYCTYLUS Raf.

Annals of Nature, March, 1820, No. 22, p. 5; Hallowell Journ. Ac. Phila. (N. S.), III, p. 363; Cope, Proceed. Ac. Phila., 1859, p. 126.

Notophthalmus Rafinesque, *l. c*, p. 5; Baird, Journ. Ac. Phila., (N. S.) I, p. 284.
Molge Merrem, Tentamen, Syst. Amphibiarum, 1820, p. 185; Boulenger, Cat. Batr. Grad. Brit. Mus., II, 6, 1882, pars.
Euproctus Géné, Syn. Reptil., Sardinia, p. 28; Bonap., Fauna Italica; Cope, *l. c.*, p. 127.
Cynops Tschudi, Batr., 1838, p. 94.
Taricha Gray, Cat. Batr. Grad. Brit. Mus., 1845, p. 25.

The hyoid apparatus in this genus is much as in the Plethodontidæ and the Salamandridæ. There is a small hypohyal, which does not articulate with the ceratohyal. In *Diëmyctylus torosus* there is a second process on each side posterior to the hypohyal,* which may be homologous with the similar second lateral cartilage in *Linguælapsus annulatus*, or even with the otoglossal cartilage. The ceratohyal is divided, the proximal half osseous. The first ceratobranchial and epibranchial are osseous. The second ceratobranchials originate from a high median longitudinal crest of the basibranchial. The free extremity of the ceratohyal is elongate, and in *D. viridescens* it extends all the way to the inferior surface of the exterior process of the exoccipital bone,† with which it is in close contact. In the *D. torosus* it does not extend so far. In both species the extremity carries with it the hyosuspensorial ligament which connects it with the quadrate bone, which thus becomes much longer than in other genera. (Plate 46, figs. 3, 4.)

What name should be applied to this genus is uncertain, and may perhaps ever remain so. The circumstances are as follows: In 1819, in the Journal de Physique,‡ LXXXVIII, p. 418, Rafinesque proposed to replace the name Triton of Laurenti by his own name, Triturus. In 1820, in the Annals of Nature§ for March, p. 4, he says: "My genus Triturus is the same as the Triton of Duméril, there being already another genus of animals called Triton. It differs from the Salamandra

* First indicated by Wiedersheim in Der Kopfskelet der Urodelen, Pl. VI, fig. 91.

† This was first shown me by Dr. E. E. Galt in one of her dissections.

‡ Prodrome de soixante-dix nouveaux genres d'animaux découverts dans l'intérieur des États Unis d'Amérique, durant l'année 1818.

§ Annals of Nature or Annual Synopsis of new Genera of Animals, Plants, etc., Discovered in North America, by C. S. Rafinesque, Transylvania University, Lexington, Ky., 1820.

in having a compressed tail." Under this genus he included five species: *T. hypoxanthus*, *T. fuscus*, *T. viridescens*, *T. nebulosus*, and *T. miniatus*. The *T. fuscus* is the *Desmognathus fusca of* Baird; the *T. viridescens* and *T. miniatus* are included under the present genus, while the application of the other two names is unknown. Under the head of the *T. viridescens* (p. 5), he remarks: "It must form a peculiar subgenus Diemyctylus, distinguished by the fore-feet semipalmate, with four equal toes, the posterior with only three toes and two lateral knobs; jaws nearly equal, eyes elliptic," etc. Immediately following on the same page the author proposes the subgeneric name Notophthalmus for the *T. miniatus*, in the following language: "It has almost the characters of the subgenus Diemyctylus, but differs yet from it by having the toes of the fore-feet free and unequal, the lateral ones much shorter, whence it may form another subgenus Notophthalmus."

The first publication of the name Triturus makes it synonymous with the Triton of Laurenti, and all subsequent uses of the name, even by the same author, must yield to this one. Now Laurenti does not include a single species of Diëmyctylus in his Triton, so that the name is not applicable to the present genus. It must be applied to a genus of Salamandridæ whose species are placed by Boulenger in the section of his genus Molge, which is without postfronto-squamosal arch.

One year later than Rafinesque, Merrem (1820) proposed the name Molge for a series of species which embraced, with those of Triturus, one species of Diëmyctylus, *D. palmatus* (*Molge palmata* Schneid.). The Trituri being abstracted by the prior name, Molge should remain for the last-named species. But it was in the same year that Rafinesque proposed Diëmyctylus for the same genus, and it now becomes a question as to the day of the year on which the works of these two authors were respectively issued. As Rafinesque's bears the early date of March, I retain it until it is shown that Merrem's Tentamen was published previously. On this point I have not as yet obtained definite information.

The two North American species of this genus differ as follows:

Head wider, flat, without keels; middle fingers and toes shorter; colors uniform, unspotted; larger ..... *D. torosus.*

Head narrow, more elevated, and with two longitudinal keels; middle fingers and toes longer; spotted more or less thickly; smaller ..... *D. viridescens.*

Both of these species are aquatic in their habits, and they are the only species found in North America which are truly so; that is, they do not live on the bottom or under stones, but swim or suspend themselves in comparatively deep water.

DIEMYCTYLUS TOROSUS Esch.

(Plates 36, fig. 2; 38, figs. 1–4; 45, fig. 8; 49, fig. 3.)

Cope, Check-List Batr., Rept. N. Amer., Bull. U. S. Nat. Mus., I, p. 28, 1875.

Triton torosus Esch., Zool. Atlas, p. 12, Pl. 21, fig. 15; Strauch, Salam., p. 30.
Salamandra beecheyi Gray, in Griff. A. K., I., p. 107, and Zool. Beechey's Voy., Pl. 31, fig. 3.
Triton ermani Wiegm., in Erman's Reise um die Erde, p. 24.
Salamandra (Triton) granulosa Skilton, Amer. Journ. (2), VII, p. 202.
Notopthalmus torosus Baird, Journ. Ac. Phila. (2), I, p. 284.
Taricha torosa Gray, Cat., p. 25; Girard, U. S. Expl. Exped., Herp., p. 5, Pl. 1, fi. 1–8.
Taricha lævis Baird & Girard, Proc. Ac. Phila., 1853, p. 302.
Triton lævis Strauch, *l. c.*
Molge torosa Boulenger, Cat. Batr. Grad. Brit. Mus., second ed., 1882, p. 20.

This fine species is of rather robust proportions. The head is wide and distinct from the neck, through the protuberance of a posterior superior angle on each side. It is also perfectly flat and smooth above, excepting a gentle slope from a line connecting the orbits to the end of the muzzle. The body is slightly compressed, and its length from axilla to groin is just equal to the length from the axilla to the end of the muzzle. The tail is long, exceeding the length of the head and body by the depth of the latter. It is very much compressed, and has a wide dermal border both on the inferior and the superior edges.

Viewed from above, the head is contracted towards the muzzle with curved lateral outlines, and the end of the muzzle is truncate. It also projects considerably beyond the lower jaw. The nostrils appear to be terminal, but directed laterally, and the space between them equals two thirds that between the bases of the eyelids, and exceeds by one-quarter the space between the internal nares. It also equals the length from the eye to the nostril, and exceeds by a very little the length of the eye-fissure.

The upper lip begins to descend posteriorly at a point half-way between the nostril and the eye, and does not rise again, but conceals the lower jaw. The rictus is just behind the posterior angle of the eye. Anterior to this point it is joined on its internal side by a short lamina, which represents the lower lip of the perennibranchiate species of Batrachia. This lip is entirely concealed, and there is no fold in front of it, on the lower jaw.

The tongue is oval, and very small. It is only free at the sides, and that but slightly. The vomeropalatine teeth are in two straight series, which converge forwards and join directly between the choanæ.

The limbs are robust, the posterior ones the more so. Applied to the side, they overlap by the length of the posterior foot with tarsus. The digits differ much from each other in length, but not so much so as in the *D. viridescens*. The second (first) finger is very short, and the fifth is a little longer, while the third and fourth are of usual length, the third the shorter. The phalanges are 1–2–3–2. The toes are arranged much as the fingers, the longer ones of medium length, and the first

very short. The lengths are, beginning with the shortest, 1–5–2–4–3. The number of phalanges taken in order is: 1–2–3–3–2. The epidermis on the extremities of all the digits is horny. There are no distinct palmar or plantar tubercles. I have not discovered any horny plates on the inner sides of the posterior legs, such as occur in the *D. viridescens* during the breeding season.

The character of the surface of the skin varies according to the season and locality. In a majority of specimens the upper surfaces are smooth, but wrinkled more or less closely. In specimens which have been exposed to drought, the surface becomes rough, with small hard projections. The lower surfaces are always studded with minute horny points so as to be hispid. These become more numerous and prominent in specimens where the dorsal integument is roughened. Lateral folds are very obscure in this species, and can only be traced on the superior part of the sides. Twelve such grooves may be counted, the first and last being opposite the humerus and femur respectively. There is a distinct transverse postgular fold. The digits have thin dermal margins towards the base. The genitalia are very prominent during the breeding season, and the orifice is longitudinal, and its edges are marked with transverse wrinkles. Internally there is a large prominent papilla, simulating an intromittent organ, which rests in a fossa, whose posterior wall is composed of a series of columnar papillæ, which radiate backwards and downwards. The free membrane of the edges of the tail is much reduced, or is even wanting, in the specimens with roughened skin.

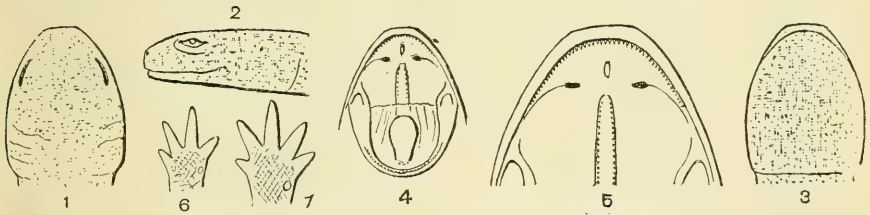

FIG. 51. *Diemyctylus torosus*. No. 11407. San Francisco; $\frac{1}{1}$, $\frac{2}{1}$.

Measurements of No. 11577.

	M.
Total length	.170
Length of head and body	.078
Length to groin	.061
Length to axilla	.026
Length to canthus oris	.012
Length to anterior canthus oculi	.005
Length of fore-leg	.027
Length of cubitus	.011
Length of manus	.0115
Length of hind leg	.030
Length of tibia	.0085
Length of pes	.0136
Interorbital width	.075
Greatest width of head	.0175
Depth of tail at middle, with fin	.014

The mucous pores of this species have the following distribution: They form a band on each side of the muzzle, which passes within the eyelid to just behind the eye, where it divides. One line extends backwards and turns towards the middle line without joining its fellow of the opposite side. The other branch passes behind and below the eye, and forms a patch on the loreal region. On the body the system consists of a series of pores along the lower part of each side.

The coloration of this species is simple. The sides and superior surfaces of the head, body, and limbs are brown, and the inferior surfaces are yellow. In rough specimens the brown becomes almost black, and the yellow is correspondingly deep. In smooth specimens the brown is pale, and has an olive tinge. The upper membrane of the tail is yellowish-brown; the lower yellow.

This species has the widest range of any Pacific salamander, since it extends from San Diego on the south to southern Alaska on the north. It is very abundant in some parts of California, and may be seen swimming in the streams and ponds in numbers.

Diemyctylus torosus Esch.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
9056	6	Puget Sound, Oregon		U. S. Expl. Exped	Alcoholic.
47	1	California			Do.
4070	1	Fort Steilacoom, Wash		Dr. Geo. Suckley, U. S. A.	Do.
4028	3	Eugene City, Oregon		Dr. C. G. Newberry	Do.
4046	3	Fort Vancouver, Wash		Dr. J. G. Cooper	Do.
9214	1	Fort Steilacoom, Wash			Do.
9215	9				Do.
11407	2	San Francisco, Cal		U. S. Expl. Exped	Do.
11577	10	do	1879	Gustav Eisen (?)	Do.
11764	2	Fresno, Cal	1879	Gustav Eisen	Do.
4052	4	Astoria, Oregon		Lieut. W. P. Trowbridge, U. S. A.	Do.
9556	1	California		Dr. Wm. Stimpson	Do.
6585	1	Monterey, Cal		Dr. Canfield	Do.
13560	1	Hassler's Harbor, Alaska		H. E. Nichols	Do.
14107	1	Lake County, Cal	1885	H. W. Turner	Do.
13940	3	Berkeley, Cal	1884	R. E. C. Stearns	Do.
13946	1	do	1884	do	Do.
13952	1	Howell Mountains, Cal	1884	do	Do.
13381	2	San Diego, Cal	1883	Chas. R. Orcutt	Do.
14479	2	Port Chester, Alaska	1883	Lt. H. E. Nichols, U. S. N	Do.
14480	2	Nisqually, Oregon		Expl. Exped	Do.
14492	1	Revillajigedo Har., Alas.	1885	Dr. T. H. Streets, U. S. N	Do.
13928	2	Baird, Cal	1885	Chas. H. Townsend	Do.
14556	2	Humboldt County, Cal		do	Do.
11764	7	Fresno, Cal		Gustav Eisen	Do.
4014	5	San Francisco, Cal		Dr. J. L. Leconte*	Do.

GENERAL SERIES.

4027	1	El Dorado County, Cal		Dr. C. C. Boyle	Alcoholic.
4015	1	San Francisco, Cal		R. D. Cutts	Do.
4014	1	do		Dr. J. L. Leconte	Do.
11852	2	San Quentin, Cal	April —, 1871	Capt. Wm. Holden	Do.
11764	10	Fresno, Cal	1879	Gustav Eisen	Do.
12751	2	Ballinas Bay, Cal		Hemphill	Do.
12153	1	Oakland, Cal		P. L. Jouy	Do.
4051	4	Petaluma, Cal		E. Samuels	Do.
11471	1	Puget Sound, Oregon		(?)	Do.
12010	4				Do.
4095	4	Fort Umpqua, Oregon		Lieutenant Michler	Do.
14450	2	(?)		(?)	Do.
14461	1	Oregon		(?)	Do.
14465	1	Kelseyville, Cal	1873	L. Stone	Do.
14469	1	Oregon		Expl. Exped	Do.

* Type of *T. laevis*.

DIEMYCTYLUS VIRIDESCENS Raf.

(Plates 36, figs. 3–4; 39; 40, figs. 5–9; 41, figs. 3–4; 42, fig. 3; 45, fig. 9; 49, fig. 4.)

Hallow., Journ. Ac. Phila. (N. S.) III, p. 363; Cope, Proceed Ac. Phila., 1859, p. 126.

Triturus (*Diemyctylus*) *viridescens* Rafin., Annals of Nature, 1820, No. 22.
Triturus (*Notophthalmus*) *miniatus* Rafin., *l. c.*, No. 24.
Salamandra stellio Say, Amer, Journ., I, p. 264.
Salamandra dorsalis Harlan, Journ. Ac. Phila., V, p. 121; Wied., Nova Acta Leop., carol., XXXII, p. 131.
Salamandra symmetrica Harlan, *l. c.*, p. 157; Holbr., N. A. Herp., V, p. 57, Pl. XVII; De Kay, N. Y. Faun , Reptil., p. 73, Pl. XV, fig. 33; Wied., *l. c.*, p. 125.
Salamandra millepunctata Storer Bost. Journ. N. H., II, p. 60.
Salamandra greenii Gray, Griff. A. K., IX, Syn., p. 107.
Triton dorsalis Holbr., *l. c.*, p. 77, Pl. XXV; Dum. & Bibr., p. 155.
Triton millepunctatus De Kay, *l. c.*, p. 84, Pl. XV, fig. 34.
Notophthalmus miniatus Baird, Journ. Ac. Phila. (2), I, p. 284; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 22.
Notophthalmus viridescens Baird, *l. c.*; Gray, *l. c.* p. 23.
Triton punctatissimus Dum. & Bibr., p. 154.
Triton symmetricus Dum. & Bibr., p. 154; Pl. 107, fig. 2.
Diemyctylus miniatus Hallow., *l. c.*
Triton viridescens Strauch, Salam., p. 50.
Molge viridescens Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 21.

This variable species is the aquatic salamander of the eastern region of North America. Its distinctive characters have been already referred to (page 203), and will be more fully detailed under its appropriate subspecies. These are two, as follows:

External finger half as long as fourth or shorter; back with small black-edged red spots..... *D. v. viridescens.*
External finger more than half as long as fourth; no red spots on back, but large black ones, which are present also on the tail..... *D. v. meridionalis.*

Diemyctylus viridescens viridescens Raf.

There are two forms of this subspecies, which have received the names of viridescens and miniatus respectively. These having been shown to be stages of one and the same animal, they are not distinguished otherwise than as seasonal forms, which may be by reason of the environment rendered permanent for a longer or shorter time. I give, however, the characters that distinguish them.

Cranial carinæ more prominent, and longer; tongue freer laterally; skin rough; cheek-pits more frequently wanting; color red..... form *miniatus.*
Cranial carinæ less prominent, especially at the ends; tongue less free; skin smooth; cheek-pits rarely wanting; ground color olivaceous..... form *viridescens.*

The form Miniatus never has a caudal fin-membrane, while it is generally present in the form Viridescens; but this is a seasonal character. The characters above mentioned are not always combined as described, and one or another may be wanting while the others are present.

They will be referred to later in this article. Meanwhile I describe a typical specimen of the form Viridescens.

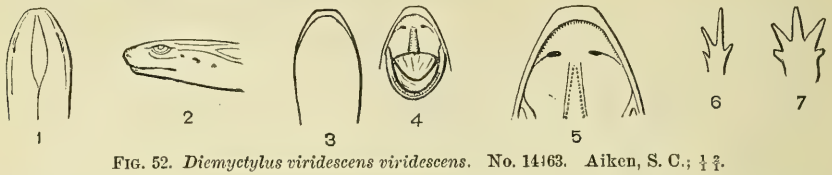

FIG. 52. *Diemyctylus viridescens viridescens*. No. 14163. Aiken, S. C.; ½.

The outline of the head seen from above is an oval, which contracts anteriorly and posteriorly, and is not distinguished from the neck by the abrupt contraction of the latter. The back is roof-shaped, and the section of the body a vertical oval. The length from the axilla to the end of the muzzle is just a little less than the distance between the axilla and the groin. The tail is much compressed throughout, and is as long as the head and body (vent included).

The muzzle, viewed from above, is truncate-rounded, and it projects a little beyond the mouth. The two ridges of the top of the head inclose a long lenticular open groove which is closed in front on the muzzle, but open behind on the occiput. On their external sides is a shallow groove. There is a distinct but obtuse canthus rostralis, and the loreal region is slightly concave. The profile is slightly decurved at the muzzle. The eye is rather large; its length exceeds a little the length from its anterior canthus to the end of the muzzle, and is a little less than the interorbital width. The nostrils are close together, and look upwards as well as outwards. The distance between them enters the interorbital space two and a half times. The eyes do not project upwards, so that the eyelids are nearly plane with the front. The lower jaw is only partly overlapped by the posterior part of the upper lip, and there is no distinct lower lip or groove. On the side of the head posterior to the eye is a straight row of four pits, the first of which is near the eye and the last is in the position of the first branchial fissure. These pits are shortly linear and curved, as though made by the pressure of an instrument with a short curved edge. The distances between them are equal to each other and to half the diameter of the eye. At the position of the posterior pit are traces of three branchial fissures in three vertical short rows of minute pits; but these are not always present. The cheek-pits, moreover, are frequently wanting. I give the results of the examination of seventy individuals of the forms Viridescens and Miniatus:

Viridescens.		*Miniatus.*	
Fossæ present	28	Fossæ present	10
Fossæ wanting	5	Fossæ wanting	25

The pits are generally symmetrical, but in a Miniatus there is but one pore on one side, and in a Viridescens there are no pores on one side and three on the other.

The tongue occupies but little space on the floor of the mouth. It is slightly free at the sides, but not at the anterior or posterior ends, which pass insensibly into the adjacent tissue. Its form is oval anteroposteriorly. The vomeropalatine teeth are in two longitudinal series, which converge anteriorly, and join after running close together between the internal nares. The latter are about as far apart as the external nares.

When applied to the side the fore limb overlaps the hind limb by the length of the hind foot. While of nearly the same length, the fore limbs are not more that half as thick as the hind limbs. Their length is just equal to the distance from the axilla to the end of the muzzle. The second (first) finger is very small, with but a rudiment free. The third finger is long, and the fourth still longer, while the fifth is longer than the second (first), but generally less than half as long as the fourth. The phalanges are 1–2–3–2.

The first and fifth toes are mere obtuse rudiments and of equal length. The other toes are not relatively so long as the fingers, standing 2–4–3 in order of length, beginning with the shortest. The phalanges are 1–2–3–3–1. In males in the breeding-season the hind legs are thickened, especially the integument of the inner side. It is then divided by transverse folds, and the portions between them become corneous or chitinous. There are thus from ten to twelve transverse plates on the inside of the thighs, and an irregular number on the inside of the tibia and tarsus. The rudimental external and internal toes have a cap of the same substance. These bodies aid the male in maintaining his hold on the female during copulation.

The skin in the form Viridescens is smooth on all the surfaces, but rather closely wrinkled. The tail has a free dermal margin or fin (of about equal width and length) on both the superior and the inferior edges. The genitalia are very prominent at the breeding season, and in the male the orifice is oval. It is very papillose, especially within the anterior border. (See Plates 39 and 41, fig. 3.) There is no transverse postgular fold, and there are no transverse lateral grooves.

Measurements of No. 3795.

	M.
Total length	.090
Length of head and body	.046
Length to groin	.036
Length to axilla	.016
Length to canthus oris	.0065
Length of fore-leg	.0145
Length of cubitus	.005
Length of fore-foot	.0065
Length of hind leg	.0175
Length of tibia	.0053
Length of hind foot	.0088
Width of head	.008
Width between orbits	.0046
Depth of tail at middle	.0075

The color of the form Viridescens is a light brownish-olive above, which is or is not marked off distinctly from the paler color of the lower surfaces along the side. The inferior surfaces are straw-color or dirty white. On each side of the vertebral line is a row of from three to six small round red spots, each with a black border. The rest of the surface is marked with small black points, which are smaller but more distinct on the lower surfaces. On the legs they are larger and more distinct, and on the tail they appear to have run like ink spots on paper placed in water. In specimens without fins they sometimes form two rows on each side of the tail and a line along the side from the axilla to the groin. There is a faint dark line from the eye to the last cheek-pit. Chin and throat generally unspotted.

In the form Miniatus the tail is narrow, being without dermal borders, The color of the superior surfaces is vermilion red and the lower surfaces citron-yellow. The red spots are present as in the other form, but the small black spots are rarely present on the back. They are present on the sides, belly, limbs, and tail, and never run together into lines. In this form the skin of all the upper surfaces is rough, with numerous minute, semitransparent horny points of the skin. These are not developed on the inferior surfaces.

These characters would be likely to follow the exposure of an aquatic

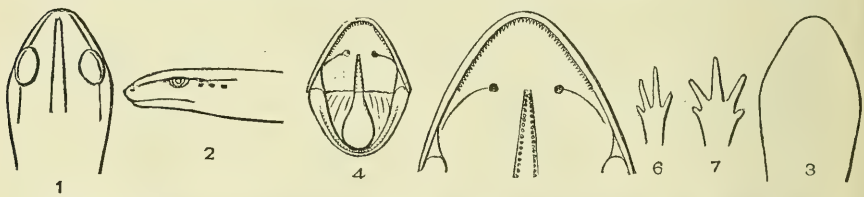

FIG. 53. *Diemyctylus miniatus miniatus* Raf. 3802. Twice natural size. Root River, Wis.

animal with soft skin to the comparative drought of the atmosphere. The greater acuteness and prominence of the cranial crests displayed by the Miniatus form is probably caused by the closer adherence of the thinner integuments under these circumstances. Direct observations as to these points, however, exist. Dr. Hallowell was the first to express his belief that the so-called distinct species were the same. I afterwards remarked, "the nominal *D. miniatus* is a state of *D. viridescens*," and that I have had it change to the latter in confinement. Dr. Howard A. Kelly, in an article in the American Naturalist, states, he "brought home a number of *D. miniatus* (Raf.), or little red lizard, or red eft, and after keeping them in a dark box filled with saturated moss, they changed their color from a bright vermilion to the olive state characteristic of the *D. viridescens*," and he kept them all winter. Col. Nicholas Pike says in the same journal (January, 1886): "I have gradually come to the conclusion that the two are identical. Some years ago I captured quite a number of red ones in the Catskill Mountains, brought them home, and kept them in a box with other salamanders, where they could resort to water

if they chose. For some days they remained hiding under the wet moss and stones, but finally crept out at night and went into the water. I gave them some insects and worms, which they readily devoured. In about three months they lost their bright red, and in less than a year they were of the usual olive of the Viridescens. Another fact, still more decidedly bearing on the case, is, that some two-year-old Viridescens taken from the ponds and put in earth and dead wet leaves in a tub in my garden, without water, in a month or so began to lose their green tint and assume a dingy, brownish hue."

Professor Baird thus describes the breeding habits of this salamander:*

"In the spring of the year a broad fin becomes developed along the tail and back of the male, and the feet enlarge, with the addition of a black cartilaginous mass on the toes and inside of the thighs, for the purpose of enabling it to hold on to the female. This it does by clasping her around the throat with the hind legs and retaining the hold for some hours or longer, jerking her around in the water most unmercifully during the whole time. A quantity of seminal matter is finally discharged, which becomes diffused in the water, and fecundates the ova while still in the lower part of the oviduct. The eggs are laid singly, of an ellipsoidal shape, and invested by a very glutinous coat, by which it is attached to the middle of an immersed leaf, which is then doubled over it by the exertions of the female. The eggs, after remaining for some time in this way, finally give birth to small larvæ, the general character of whose metamorphosis is much the same as that of the species already described." I have found the habits of specimens of this species in confinement quite as described by Baird. I found the axils of the leaves of *Utricularia* to be used as places for the deposit of eggs by the female. (See Journal Philadelphia Academy, 1866, p. 68.)

Diemyctylus viridescens meridionalis Cope.

Bulletin U. S. Nat .Mus., No. 20, 1880, p. 30. *Molge meridionalis* Cope; Boulenger, Ann. Magaz. Nat. Hist., 1888, January.

This subspecies has the longer digits of the form Miniatus, and low cranial crests of the Viridescens, with which it also agrees in color. From both forms it differs in the absence of red spots from the dorsal region, which is instead covered with rather large black spots, which continue on the tail. The ground above is olive ; below it is yellow, which is marked with numerous small black spots. A character which appears to be of importance is seen in the fore foot. The outer toe is more than half as long as the penultimate, while in the varieties Viridescens and Miniatus it is less than half as long.

The first specimen of this form which I met with was sent to the Smithsonian Institution from Matamoros, Mexico. G. W. Marnock

*Iconogr. Encycl., vol. II, p. 254, 1851.

finds it in the tributaries of the Medina River and southward, and William Taylor has obtained a good many specimens from San Diego, in southwestern Texas. It has not been found east of that region. I did not see it in the plateau country.

Dr. Boulenger thinks that this form should be regarded as a distinct species. Besides the characters I have cited he says the head is more depressed and the lores less vertical and the gular fold more distinct, than in the *D. viridescens*.

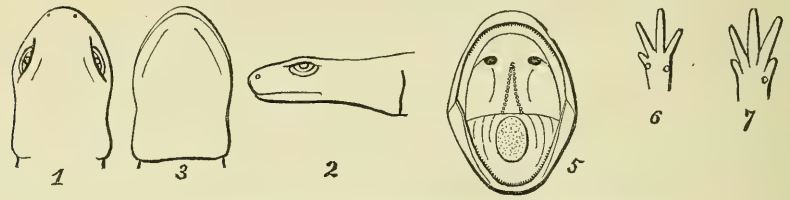

FIG. 54. *Diemyctylus viridescens meridionalis*. San Diego, Tex.; ½.

Diemyctylus viridescens miniatus Raf.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3802	3	Root River, Wis		Prof. S. F. Baird	Alcoholic.
3819	6	Cook County, Ill		R. Kennicott	Do.
3864	6	Meadville, Pa		Professor Williams	Do.
8958	1	Kinston, N. C		J. W. Milner	Do.
8824	1	Cincinnati, Ohio		J. N. B. Scarborough	Do.
7829	2	Washington, D. C		Dr. E. Coues, U. S. A.	Do.
9299	1	Norfolk, Conn.	Sept. 26, 1877	A. F. Wooster	Do.
3793	5	West Point, N. Y.		Prof. S. F. Baird	Do.
9393	3	Upper Miss. Valley			Do.
9305	1				Do.
4026	1	Brazos River, Tex.		Dr. B. F. Shumard	Do.
9189	6	(?)		(?)	Do.
9279	1	(?)		(?)	Do.
11465	3	(?)		(?)	Do.
9555	6	Aux Plains River, Ill		C. B. R. Kennicott	Do.
13581	1	Washington, D C	Oct., 1883	E. H. Hawley	Do.
5969	1	Hudson Bay		C. Drexler	Do.
13585	2	Rawley, Va		Ben. Miller	Do.

Diemyctylus viridescens viridescens Raf.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3492	7	Aux Plains River, Ill		R. Kennicott	Alcoholic.
3808	4	Tioga County, N. Y.		E. E. Howell	Do.
3795	6	Carlisle, Pa		Prof. S. F. Baird	Do.
7902	10	do		do	Do.
5042	2	Georgia		Dr. W. L. Jones	Do.
5416	6	Illinois (?)		R. Kennicott	Do.
3817	10	Abbeville, S. C		Dr. J. B. Barratt	Do.
3826	3	New York		Prof. S. F. Baird	Do.
8849	10	Lexington, Va		Fred. Mather	Do.
9290	4	Moulton, Ala			Do.
12053	4	Mount Carmel, Ill	Nov. —, 1881	L. M. Turner	Do.
3803	6	Jersey City, N. J			Do.
9557	6	St. Catharine's, Canada		Dr. D. W. Beadle	Do.
7056	7	Grand Coteau, La		St. Charles College	Do.

Diemyctylus viridescens viridescens Raf.

GENERAL SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
7902	77	Carlisle, Pa		Prof. S. F. Baird	Alcoholic.
3795	67	do		do	Do.
9118	1	Smith County, Va		A. L. Kumlien	Do.
9331	1	Virginia	May 28, 1876	Fred. F. Talbot	Do.
3814	9	James River, Virginia	Feb. 20, 1877	S. F. Baird	Do.
3799	1	Wisconsin		do	Do.
14021	1	Norfolk, Conn	July, 1853	Dr. Wm. H. Jones	Do.
13424	3	Garrison's, N. Y	Nov. 1884	T. Rooseveldt	Do.
3801	4	Cook County, Ill	1876	R. Kennicott	Do.
14463	16	(?)		(?)	Do.
14463	1	Aiken, S. C		(?)	Do.

Diemyctylus viridescens meridionalis.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
	2	Matamoras, Tamaulipas		Lieutenant Couch	Alcoholic.
	3	San Diego, Tex		W. Taylor	Do.

AMPHIUMIDÆ.

Ethmoid bone present; vestibule osseous internally. No malar or quadratojugal bones. Vertebræ amphicœlous, with two anteriorly directed hypapophyses at the anterior extremity. Scapular and pelvic arches and limbs present. Vomerine teeth on anterior or external border of vomer, which does not bound the choanæ posteriorly. No parasphenoid teeth. Liver not finely divided. Cloaca without projectile muscles. Tail developed. No external gills. There is but one ceratobranchial bone, and but one basibranchial. There are three epibranchials. Besides hypohyals there are basihyals. No otoglossal. The stapes is directly connected with the quadrate by cartilage.

By all authors the genus Amphiuma had been included in the same family division with Protonopsis and Megalobatrachus until 1866. At that time the writer proposed to separate it from the latter genera as the type of a family Amphiumidæ, while the other genera were placed in another family with the name Protonopsidæ. This course has not been followed by later writers; in the catalogue of the British Museum by Dr. Boulenger (1882), for instance, the three genera are included in one family, the Amphiumidæ.

The reasons for keeping the Amphiumidæ distinct from the Protonopsidæ were stated to be the following:*

AMPHIUMIDÆ: "An axial cranial bone (? vomer) in front of orbitosphenoids, and one forming palatal surface in front of parasphenoid. * * * Parietals prolonged laterally, not reaching prefrontals. Vesti-

* Journ. Ac., Phila., 1866, p. 104.

bule, wall osseous internally. Premaxillaries consolidated. Occipital condyles on cylindrical pedestals."

PROTONOPSIDÆ: "No anterior axial cranial bone. * * * Parietals and prefontals prolonged, meeting and embracing frontals. Wall of vestibule membranous internally. Premaxillaries separated. Occipital condyles sessile."

The following observations were made on the Amphiumidæ: "The occipital condyles and temporocervical tendon are quite as in Desmognathus; they have not been previously described.* In *Amphiuma means* there is a minute non-articulated bone on the suture between the o. o. frontalia and prefontalia in the situation of the lachrymal. There are some approximations to Cæcilia in Amphiumidæ. It does not appear to have been noticed that the * * * free margin of the frontal seems to foreshadow the overroofing of the orbit and temporal fossa seen in Cæcilia. There is also a very large foramen or canal passing through the o. maxillare from near its middle to the orbit, foreshadowing the *canalis tentaculiferus* of Cæcilia: a narrow one occurs in the same situation in Protonopsis. Further, the prominent horizontal anterior inferior processes of the vertebral centra are the same in Amphiuma and Cæcilia."

The characters assigned as above to the two families Amphiumidæ and Cryptobranchidæ are abundantly sufficient for retaining them as distinct.† The form of the occipital condyles might be excepted from this estimate, and the axial bone in front of the parasphenoid proves to be abnormally cut off in the specimen then examined. The Protonopsidæ agree with other Urodela in all of the characters given, except in the exclusion of the frontals from the supraorbital border, and in the membranous characteristic of the internal wall of the vestibule. The Amphiumidæ differ from other Urodela in the presence of a large ethmoid bone (the one referred to as ? vomer in the diagnosis above quoted), in the presence of temporal ridges, and of two anteriorly directed hypapophyses of the precaudal vertebræ.

It is interesting to notice that three of the four characters just cited are shared by the Cæciliidæ. The presence of the ethmoid is of especial importance, as it is an element constantly wanting in the Urodela. I have not found it in Desmognathus, Anaides, Spelerpes, Amblystoma, Salamandra, nor Cryptobranchus, nor is it present in Necturus or in Siren. It is, on the contrary, always present in Cæciliidæ‡ (see Plate IX, 3). The double anterior hypapophyses are otherwise confined to the same family.

The characters of the hyoid arches also distinguish this family from the Cryptobranchidæ, and they differ from those of the Pseudosauria

* They were described by Dr. J. G. Fischer, Anatomisch. Abhandl. üb. Perennibranch. u. Derotrem., Erstes Heft, p. 61, 1864.

† Proceed. Amer. Philosoph. Soc., 1886, p. 442.

‡ Wiedersheim, Anatomie der Gymnophionen, Jena, 1879.

as well. They are unique in the presence of only one ceratobranchial, Necturus only approaching it in this respect. In the absence of the second basibranchial it agrees with Cryptobranchus, and approaches the Pseudosauria, where a part of it only remains. It also agrees with Cryptobranchus in the absence or confluence of the first epibranchial and in the presence of the three succeeding epibranchials.

This family is only known from North America.

There is but one genus of this family, which is defined as follows:

A pharyngeal slit on the side of the neck; vomerine teeth in antero-posterior series; no scales; limbs much reduced; digits, two or three on each foot; prefrontal and nasal bones present; a temporal crest; palatine bone not inclosing choanæ posteriorly; premaxillary bones coössified ..... *Amphiuma*.

AMPHIUMA Garden.

Smith's Correspondence of Linnæus, I, p. 599; Wagler, Systema Amphib., 1830, p. 239; Tschudi, Batr., 1829, p. 67; Gray, Cat. Batr. Grad. Brit. Mus., 55; Dum., Bibr., IX, p 201; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, p. 82; Ryder, Proceeds. Acad. Phila., 1879, p. 14; Cope, Proceeds. Amer. Philosoph. Soc. 1886, p. 442.

Chrysodonta Mitchill, Medical Recorder, 1882, p. 529.
Sirenoides Fitz., Syst. Reptil. 1826, p. 34.
Muræ nopsis Fitz., *l. c.*; Gray, *l. c.*

The only portion of the shoulder girdle of this genus which is ossified is the scapula. The coracoid cartilages of opposite sides are distinct from each other, and there is a production of the precoracoid region The humerus is truncate at both extremities, making its articulations with cartilage only. The carpus is cartilaginous. The osseus ilium is quite short and slender; it has a long superior cartilaginous portion, which is attached to an equally long cartilaginous sacral rib. The inferior element is an undivided plate, which is wider than long, and presents an obtuse angle anteriorly. The posterior portion of each is occupied by a round discoid ossification, which forms the posterior border, but does not reach either the acetabulum or its fellow. The femur is rather long and has a distinct trochanter, but no head or condyles. The articulations are cartilaginous, as is the tarsus, which is also undivided. The tibia and fibula are about one-sixth the length of the femur, and the fibula is a little shorter and more slender than the tibia. The phalanges in both feet are well ossified.

The general character of these parts are described in Stannius' Handbuch der Zoölogie, but only as included in the definitions of the order to which Amphiuma is referred.

Professor Ryder demonstrated the identity of this genus and *Muræn-opsis*.

The range of this genus is the Austroriparian region. It has not been found west of Louisiana, nor in the Mississippi valley north of Arkansas. It occurs in the Floridan district.

AMPHIUMA MEANS Garden.

(Plates 9, fig. 7; 10; 11, figs. 1–9; 12; 13, fig. 5.)

Holb., N. A. Herp., v, p. 89, Pl., 30; Dum. & Bibr., p. 203; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 55; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 83; Cope, Check List Batr. Rept. N. Am., 1875, p. 25; Proceeds. Amer. Philos. Soc., 1886, p. 526.

Chrysodonta larvæformis Mitch., *l. c.*

Amphiuma means s. *didactyla* Cuv., Mém. Mus., XIV, p. 4, Pl. 1, fig. 1–3.

Amphiuma didactyla Wagl., Syst. Amph., p. 209.

Sirenoides didactylum Fitz., *l. c.*

Amphiuma tridactyla Cuv., Mém. Mus., XIV, p. 7, Pl. 1, fig. 4–6; Holbr., N. A. Herp., v, p. 93, Pl. 31; Tschudi, Batr., p. 97; Dum. & Bibr., p. 203; Ryder Proc. Ac. Phila., 1879, p. 14; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 82.

Muræopsis tridactyla Fitz., Syst. Reptil. p. 34; Gray, Cat. Bat. Grad. Brit. Mus., ed. I, p. 55; Cope, Check-List Batr. Reptil. Nearctic Realm, 1875, p. 25.

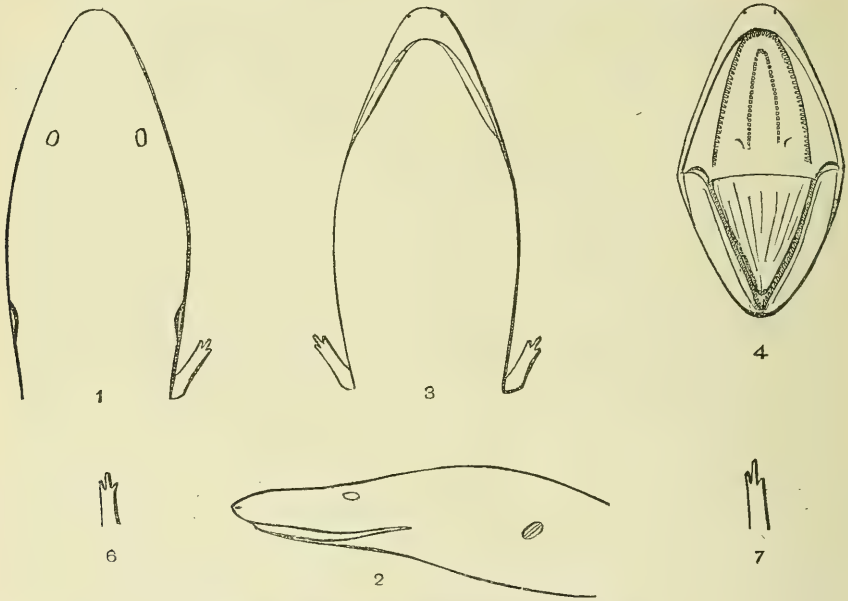

FIG. 55. *Amphiuma means.* No. 10865. Columbus, Miss; ½.

In this species the general form is elongate, and much like that of an eel. Of this length the tail occupies a proportion which varies from a little less than one-fourth to a little less than one-fifth. This proportion depends on age, the large adults having shorter tails than the small and young ones. The body is depressed cylindric in form. The form of the tail differs in different individuals from a vertical oval in section, to a triangle in section, with the angle upwards. Its extremity is always strongly compressed, and is slender, and the superior surface may be rounded or angulate. There is no distinct contraction representing a neck. The head is an oval, and is narrowed very grad-

ually to the extremity of the rounded muzzle. It is much depressed also, so that the range of vision is vertical. The end of the muzzle projects beyond the mouth, but the sides do not project. The number of lateral dermal grooves is about sixty.

The eyes are quite small, and are separated by an interspace of five times their transverse diameter. They have no lids, so that the cornea is continuous with the cephalic epidermis. The external nostrils are minute, and are separated by an interval a little less than half the interorbital space. The lips are large and full, those of the upper jaw overhanging, and concealing those of the lower except at the end of the muzzle. The lower lips commence on each side of the symphysis, and are decurved over the integument of the ramus, from which they are separated by a deep longitudinal groove.

In the premaxillo-maxillary series there are thirty-one teeth. The series terminates below a point posterior to the eye, and a little in front of the rictus oris. The vomerine series form a $\wedge$ with the apex forwards. Their posterior end is nearly but not quite so far posterior as the extremity of the maxillary row. All the teeth are compressed, and their anterior edge is abruptly recurved towards the apex, so that the apex looks partly posteriorly. The posterior nares have a valvular opening, which looks backwards and outwards a little in advance of the extremity of the vomerine series, and nearer to them than to the maxillaries. The tongue is represented by a muscular mass, which occupies the floor of the mouth. It is only free laterally, being separated by a deep groove from the mandibular ramus. This groove is vertically divided by a membranous lamina for its entire length.

The skin is everywhere smooth. The segmental grooves are only distinct on the sides; on the belly they are indistinct, and on the dorsal region they are entirely wanting. There are numerous mucous pores on the head. There are three rows on the maxillary region, the superior of which ceases below the eye, in front of a line falling perpendicularly from it. The median row terminates in one or two large pores a little behind below the eye. The inferior row extends farther and then becomes transverse, and joins the superior branch of the superciliary row three diameters of the eye behind and within it. There is a row on each side of the muzzle, which terminates in front of a line connecting the fronts of the eyes. Its place is taken by a superciliary row, which forks behind the eye. The inferior half ceases behind the eye two diameters, while the superior one joins the transverse continuation from the inferior maxillary, and is continued a short distance over each temporal muscle. There are no distinct rows of pores on the body. The head pores may differ somewhat from those described above from a large specimen (No. 6300). Thus there may be only two maxillary series, and the superciliary row may not be distinctly divided. There are two rows along the superior part and two rows along the inferior part of the lower jaw.

The branchial fissure is situated nearly as far posterior to the canthus oris as the latter is posterior to the end of the lower jaw. It is in the anterior part of a fossa, and is bordered anteriorly and posteriorly by a narrow free membranous lamina. A short distance behind and below this is situated the anterior limb. The length of the limb is equal to the interocular space; in some specimens a little less. The humerus makes an angle with the rest of the limb, but the foot is continuous with the cubitus; it is divided into either two or three toes. The posterior limb is larger than the anterior, measuring nearly half as long again. Its posterior border originates a very short distance in front of the anterior extremity of the vent. It is compressed, and gently curved inwards at the knee joint. It is directed posteriorly, not quite reaching the posterior extremity of the vent. It is divided into two or three digits. The vent is a longitudinal slit, with a prominent margin. Its internal face is densely pappillose within the marginal border.

Measurements of No. 6300.

	M.
Total length	.886
Length of tail	.182
Length to canthus oris	.047
Length to branchial fissure	.077
Length to fore limb	.089
Length of fore limb	.0175
Length of hind limb	.024
Width between nostrils	.008
Width between eyes	.018
Width of head at canthus oris	.045

In specimens in alcohol the color is a dark slaty brown above and slate colored below. Its colors in life are said by Dr. Holbrook to be the same.

I have united into a single species the *Amphiuma means* and *A. tridactyla* in the above account. The description was made from a specimen (No. 6300) in which there are two toes on the anterior and three toes on the posterior limb. In two specimens of the National collection on the toes are 3–1 and 2–1 in front. In the numerous specimens (No. 7013) from Mississippi the toes are variable also. Mr. Ryder* has pointed out that one specimen displays the digits $\frac{2}{2}$ $\frac{3}{3}$; a second $\frac{2}{2}$ $\frac{3}{2}$; a third $\frac{1}{1}$ in front; others have the characters of the Means type, $\frac{2}{2}$ $\frac{2}{2}$, and others the Tridactyle character, $\frac{3}{3}$ $\frac{3}{3}$. All are young and from the same locality. Mr. Ryder concludes from these facts that the two supposed genera must be united. In this I agree with him; and after a study of the specimens in the National Museum and in my own collection, I believe that the two species on which these supposed genera rest are not distinguishable. I find no characters peculiar to any set of individuals.

Development.—Prof. O. P. Hay has observed the habit of this spe-

* Proceed. Phila. Ac., 1879, p. 14.

cies at the period of development of the young and describes them in the following language :*

"At the close of August, 1887, I spent a few days in Little Rock, Ark., in the employ of Dr. Branner, of the Arkansas geological survey. On September 1 I visited a cypress swamp in the vicinity of the city for the purpose of collecting some reptiles. During the severe summer drought this swamp had been almost completely dried up, and there was little chance to get anything except by turning over pieces of fallen timber. Beneath a log of considerable size I found to my surprise a large animal coiled up, which by its smooth glistening skin I immediately saw could not be a snake; but, having never before seen a living Amphiuma, it took me some time to realize that I had before me one of these animals. After making due preparation to prevent its escape I gave the animal a push with a stout stick, and then, no attempt at retreat being made, I lifted it out of the slight depression in which it was lying and let it straighten itself out. Meanwhile I had observed, lying in the midst of the coils, a mass of moist-looking matter, nearly as large as one's fist. Picking this up, I discovered it to be a mass of eggs. This was put into a jar of alcohol, and immediately the young within the egg could be seen writhing about, thus showing that they were in an advanced stage of development. The mother offered no resistance on being handled, and was put into a small school-satchel and carried to the State geologist's office, a mile away, with two empty fruit-jars lying on her. That night she was kept in an empty boat-box. This was some eighteen inches in height, and from it she made efforts to escape. She would erect herself in one corner until her head was on a level with the edge of the box, but she could get no farther. Once in falling down she uttered a shrill sound somewhat like a whistle or the peeping of a young chicken. A cry like that of a young duck has been attributed by some observer to the Siren, but Barton in some of his writings denies the statement that such a sound is made.

"The limbs of these animals are very small. For instance, of this one, having a length of 31 inches, the hinder limbs are only three-fourths of an inch long, the anterior only one-half an inch. Yet, when it was moving over the ground or the floor, it was amusing to observe that its feet were put forward and drawn back, as if they really could be of some use.

"On irritating this Amphiuma by pushing her with a stick she would snap at it viciously, and on further irritation would seize it in her jaws and, springing from the floor in the form of a spiral, would turn rapidly round and round, thus twisting the stick in one's hand. Any enemy thus attacked would certainly find his interest in the affair fully aroused.

"There are two points in the structure of the adult to which I wish to call attention; although no doubt they have already been observed

*American Naturalist, April, 1888.

by anatomists. The first is that there is a little lobe of skin forming the anterior boundary of the gill opening and another forming the posterior border. These can be very closely applied to each other, and seem to form a very efficient valvular apparatus, by means of which this useless relic of its larval life may be closed up. The other structure is connected with the mouth. The lower lip is formed of a fold of skin that is separated from the skin of the throat by a deep groove that runs from the corner of the mouth to near the symphysis. This fold has a thin sharp edge, and is directed downward and outward. The upper lip also has a sharp edge, which, when the mouth is closed, widely and closely overlaps the lower lip. This arrangement of the lips and that of the gill opening seems to me to have relation to the burrowing habits of these animals, and are designated to prevent the mouth and pharynx from being filled with mud.

The eggs of the Amphiume are the most remarkable that I know of as occurring among the Amphibians. The young, which now constitute the whole contents of the eggs, are surrounded by a transparent capsule about as thick as writing paper, and these capsules are connected by a slender cord of similar substance. It is as if the gelatinous mass surrounding the eggs of the toad should become condensed into a solid covering and a connecting cord. How many strings there are of these eggs I can not determine with certainty, on account of their being inextricably intertwined; but, since there are four ends visible, there are probably two strings, one for each oviduct. For the same reason I have not been able to count the eggs. A careful estimate makes at fewest 150 of them.

"The eggs in their present state are nearly globular, and average about 9^{mm} in diameter. Their distance apart on the string varies from 5 to 12^{mm}; fourteen of them were counted on a piece of the string 9 inches long. At this rate the whole mass would form a string about 8 feet long. The connecting cord varies from 1.5^{mm} to one-half that diameter. The eggs greatly resemble a string of large beads.

"The young are coiled within the capsules in a spiral form. On removing them and straightening them they measure about 45^{mm} in length. The color is dusky above, with indications of a darker dorsal stripe, and on each side a similar darker band. Below the color is pale. The body is proportionally stouter than in the adult and the head broader. The fore and the hind feet have each three toes.

"The young possess conspicuous gills; and, since they are evidently near the period of hatching, it is but fair to suppose that they would continue to retain these gills for some time after exclusion. The gills are three in number on each side, and are simply pinnate in form. The median gill is longest, measuring some 9^{mm} in length. From its main axis there arise about ten delicate twigs. The other gills are somewhat shorter, and give origin to about eight lateral twigs each. In all these filaments may be seen the blood-vessels filled with the large blood-cor-

muscles for which Amphiuma is noted. Three gill-slits are open, of which the two posterior become closed in the adult. The eyes appear to better advantage than later in life.

"The finding of these young nearly ready for active life in such an unexpected situation suggests some interesting problems. At what period of their development are these eggs deposited? If at an early period, the mother must incubate them for a considerable time. If at a late period, why should they be placed in such a situation? In either case it appears to be quite probable that they are fertilized before they are deposited. Again, how are the eggs in such a dry situation saved from being thoroughly desiccated? They are, I think, kept moist by the body of the mother as she lies coiled around them. My remembrance of her as she lay when first exposed is that she was much plumper than she now appears in alcohol; and when she was laid down on the office floor every spot she touched was made wet. The source of this water I do not know; but it appears probable that it came from the numerous glands that fill the skin, and that the mother makes nocturnal visits to the water to lay in supplies."

FIG. 56. *Amphiuma means.* Three eggs, with embryos in different positions. From Hay, American Naturalist, 1888.

The Amphiuma presents towards the salamanders the nearest affinity to the Desmognathidæ. The pedunculate occipital condyle and atlantal insertion of the temporal muscle are the same in both, and are related to a similar form and probably similar use of the muzzle. By this arrangement the temporal muscle lifts the entire head by its insertion in the lower jaw, thus taking the place of cervical muscles. It can thus use the muzzle as a lever to burrow in mud and stones. *Amphiuma means* also resembles the species of Desmognathus in the possession of a chirrup or whistle. I do not know of another American salamander which possesses a voice. The eggs in both genera are laid in a rosary. I suspect that Amphiuma is a type which has degenerated from a salamander like Desmognathus, but which possessed an ethmoid bone.

Amphiuma means Gard.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
9707	1	Arlington, Fla	1878	G. Brown Goode	Alcoholic.
10011	1				Do.
10891	1	Oakley, S. C		H. L. Barker	Do.
10899	1				Do.
6300	1	Fort Jessup, Ark			Do.
4533	1	Tarborough, N. C		J. L. Bridger	Do.
7013	10	Biloxi, Miss		C. Bellman	Do.
7065	2	Riceborough, Ga		Dr. W. L. Jones	Do.
7062	1	Charleston, S. C		Dr. S. B. Barker	Do.
7048	2			C. B. Adams	Do.
11592	1			Dr. Webb	Do.
14561	1	Nashville, Ga	July—1880	W. J. Taylor	Do.
4534	2	Prairie Mer Rouge, La		James Fairie	Do.
10865	1	Columbus, Miss		Spillman	Do.
14448	4	New Orleans, La	1883	Dr. R. W. Shufeldt, U. S. A	Do.
7064	1	Charleston, S. C		Dr. Shumard	Do.

CÆCILIIDÆ.

Apoda Oppel; *Pseudophidia* De Bl.

Vertebræ amphicœlous, with anterior double hypopophyses. Vestibule with internal wall osseous. Ethmoid well developed. Squamosal and parietal more or less extended over temporal fossa. Scapular and pelvic arches wanting. Orbit surrounded by the maxillary bone. Liver much subdivided. Testes, several on each side. Two protractile muscles of the male rectum, which project a portion of it as an intromittent organ.

This family has been usually regarded as representing a distinct order of Batrachia. I have discussed this question under the head of the order Urodela, within which I have placed it as a suborder, which should bear De Blainville's name Pseudophidia. Besides the structural peculiarities already pointed out, Peters and Sarasin have shown the branchial apparatus of the larva to be peculiar. Instead of forming loops in fibrillæ of processes of the branchial arches, the branchial vein and artery ramify on the surface of membranous bladder-like expansions of the arches.

The numerous species of this family are distributed throughout all tropical regions except those of the Australian realm. They are most abundant in tropical America. Their habits are subterranean, their lives being mostly spent in the nests of ants, which they eat. At the proper season they repair to the water and deposit their eggs. The larvæ pass through their metamorphosis early in life. All of the species are nearly blind.

This family appears to me to have been derived from the leg-bearing Urodela through the Amphiumidæ, by a process of degeneration. Additional evidence in favor of this view is found in the discovery by Strasser, of small cartilages in the position of the inferior elements by the scapular arch. This degeneration may be regarded as the result of the

inactive life consequent on parasitic habits. The same result has befallen the Lacertilian family Amphisbænidæ and the Ophidian family of Typhlopidæ. Both of these are, like the Cæciliidæ, parasitic in ants' nests, and both have become nearly blind and have lost their organs of progression, whether limbs or abdominal scales. To aid them in their dark habitat a peculiar tentacle has been developed in this family, which issues from a canal of the maxillary bone. This canal passes from the orbit, and the tentacle which occupies it is furnished with a muscle and nerve (Weidersheim). It is probably homologous with the "balancer" of the urodelous larva, which sometimes persists as a non-retractile tentacle in several of the species of the salamandrine genus Spelerpes.

The Cæciliidæ have been divided into a number of genera by Peters. The presence or absence of minute scales defines some of these, and the form and position of the tentacular opening others. Some of the latter do not appear to the writer to be well founded.

No species of the Cæciliidæ enters the geographical boundaries of the nearctic realm.

Plate 11 represents the skull and some vertebræ of the *Chthonerpeton indistinctum*, R. & L., a representative of the family from Brazil.

TRACHYSTOMATA.

Vomeropalatine bones wanting. Supraoccipitals, intercalaria, and basioccipitals wanting. Maxillary bones wanting. Propodial bones not coössified; caudal vertebræ distinct.

This order, which was proposed by Müller, has but few living representatives, nor has paleontology disclosed with certainty any extinct ones. The range of its variation being thus unknown, I confine myself chiefly to a discussion of the characters of the only family which it contains, the Sirenidæ. The order is distinguished, as above indicated, by the absence of many bones of the skull usual in vertebrata and Batrachia—a result which is apparently due to a long process of degeneracy.

SIRENIDÆ.

Vertebræ amphicœlous; pterygoidea wanting; premaxillary and dentary bones toothless; patches on the parasphenoid; two pairs of ceratobranchials; a second basibranchial continuous with the first; several epibranchials; no otoglossal; the stapes not directly connected with the quadrate; mandibular articulation by a ball-and-socket joint, the ball on the mandible, the cotylus in the quadrate.

In the known genera of the family the nasal bones are embraced by the spines of the premaxillary bone; the vomeropalato-pterygoid arch

is present as a cartilaginous band; the prefrontal bones are wanting; the orbitosphenoids are large and expanded laterally in front, so as to form part of the palatal surface. The carpus is cartilaginous, and there are no hind legs or pelvic arch. There are external branchiæ, which consist of branching processes of the integument of the epibranchial elements. The latter are separated by branchial fissures of the walls of the pharynx.

In the genus Siren the cranial extremity of the ceratohyal is free from the cranium, but is connected with the stapes by a strong ligament. In this respect this genus resembles the adults of the true salamanders, or Pseudosauria, rather th an the other perennibranchiate forms, or the Tre motodera and Amphiumoïdea. In its four epibranchial cartilages, however, it resembles the larvæ of the Pseudosauria, as also in the presence of a second basibranchial, connected with the first anteriorly, and expanding posteriorly. This mixture of characters of the adults and of the larvæ of pseudosaurian urodela has a significance which I will further illustrate.

I have already pointed out (American Naturalist, 1885, p. 245) that palæontology shows that the order of Trachystomata is a degenerate type, if the structure of its skull, limb-arches, and limbs be considered. I have also reason to believe that there are indications of a retrograde metamorphosis to be found in the history of its branchial apparatus. I was for a long time at a loss to account for the curious condition which I had observed in the branchiæ of the sirens. The fringes are frequently in a state of apparent partial atrophy and inclosed in a common dermal investment of the branchial ramus, or all the rami are covered by a common investment, so as to be absolutely functionless and immovable This character observed in the *Pseudobranchus striatus*, gave origin to its separation from the genus Siren. The character is, however, common to the *Siren lacertina* at a certain age, and the real difference between the genera depends on the different number of the digits and pharyngeal fissures in the two.

I have also observed that the functionless condition of the branchiæ is universal in young individuals of the *Siren lacertina* of five and six inches in length, and that in a specimen of a little over three inches they are entirely rudimentary and subepidermal. I have, in fact, noticed that it is only in large adult specimens that the branchiæ are fully developed in structure and function. The inference from the specimens certainly is that the branchiæ are in the sirens not a larval character, as in other perennibranchiate Batrachia, but a character of maturity. Of course only direct observation can show whether sirens have branchiæ on exclusion from the egg; but it is not probable that they differ so much from other members of their class as to be without them. Nevertheless, it is evident that the branchiæ soon become functionless, so that the animal is almost if not exclusively an air breather, and that functional activity is not resumed till a more advanced age. That Sirens

may be exclusively air breathers I have shown by observations on a specimen in an aquarium which, for two months, probably from the attacks of fishes, had no branchiæ at all. (See Journ. Ac., Phila., 1866, p. 98).

In explanation of this fact, it may be remarked that this atrophy can not be accounted for on the supposition that it is seasonal and due to the drying up of the aquatic habitat of the sirens. The countries they inhabit are humid, receiving the heaviest rain-fall of our Eastern States, and there is no drought. The only explanation appears to me to be that the present Sirens are the descendants of a terrestrial type of Batrachia, which passed through a metamorphosis like other members of their class, but that more recently they have adopted a permanently aquatic life, and have resumed their branchiæ by reversion.

This hypothesis is confirmed by the relations of the stapes to the suspensor of the lower jaw. It is not connected with the quadrate cartilage, as is the case with the Protiidæ, Cryptobranchidæ, Amphiumidæ, and the larvæ of salamanders, but is distinct and is connected posteriorly with a stapedius muscle as in adult salamanders.* (See Pl. 46, fig. 5.)

There are but two known genera of this family, which differ as follows:

Digits four; branchial fissures normally three ..... *Siren.*
Digits three; branchial fissures one ..... *Pseudobranchus.*

SIREN Linnæus.

Amœnitates Academicæ, VII, 1765, p. 311 (teste Holbrook); Systema Naturæ 12, ed. I, p. 371, 1766; Op. cit. 13, ed. I, Addenda, 1767; ibid., Turton's ed., 1802, I, p. 671; Tschudi, Batrachia, p. 98; Gray Cat. Brit. Mus., p. 68; Dum. & Bibr. Erp. Gen., IX, p. 191; Boulenger, Cat. Grad. Brit. Mus., ed. II, p. 86, 1882.

Phanerobranchus, pt. Leuckart Isis von Oken, 1821, p. 260.

Digits four; jaws with horny sheath; tongue large, free in front; eyes distinct; external branchiæ three. A patch of teeth on each side of the palate standing on three plates, which are attached to the parasphenoid bone. Three branchial fissures on each side in the adult.

In this genus there are narrow cartilages on the approximated extremities of the first basibranchial and the ceratohyals, in the position of a basihyal and hypohyals respectively.

The transverse processes of the vertebræ are very much expanded horizontally at the base, but they terminate in a pointed apex.

* American Naturalist, 1888, p. 464.

SIREN LACERTINA Linn.*

Amœnitates Academicæ, VII, p. 311, 1765; Systema Naturæ, ed. 13, I Addenda; Cuv. in Humb. Obs. Zool., I, p. 28, Pl. 11–14; Daud., Reptil., VIII, p. 272, Pl. 49, fig. 2; Holb., N. A. Herp., V, p. 101, Pl. 34; Tschudi, *l. c.;* Dum. & Bibr., p. 193 (part); Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 87.

Phanerobranchus dipus Leuckart, *l. c.*

Siren intermedia Leconte, Ann. Lyc. N. Y., 1828, p. 133, Pl. 1; Holbr. *l. c.*, p. 107, Pl. 35; *id., ibid,* p. 69.

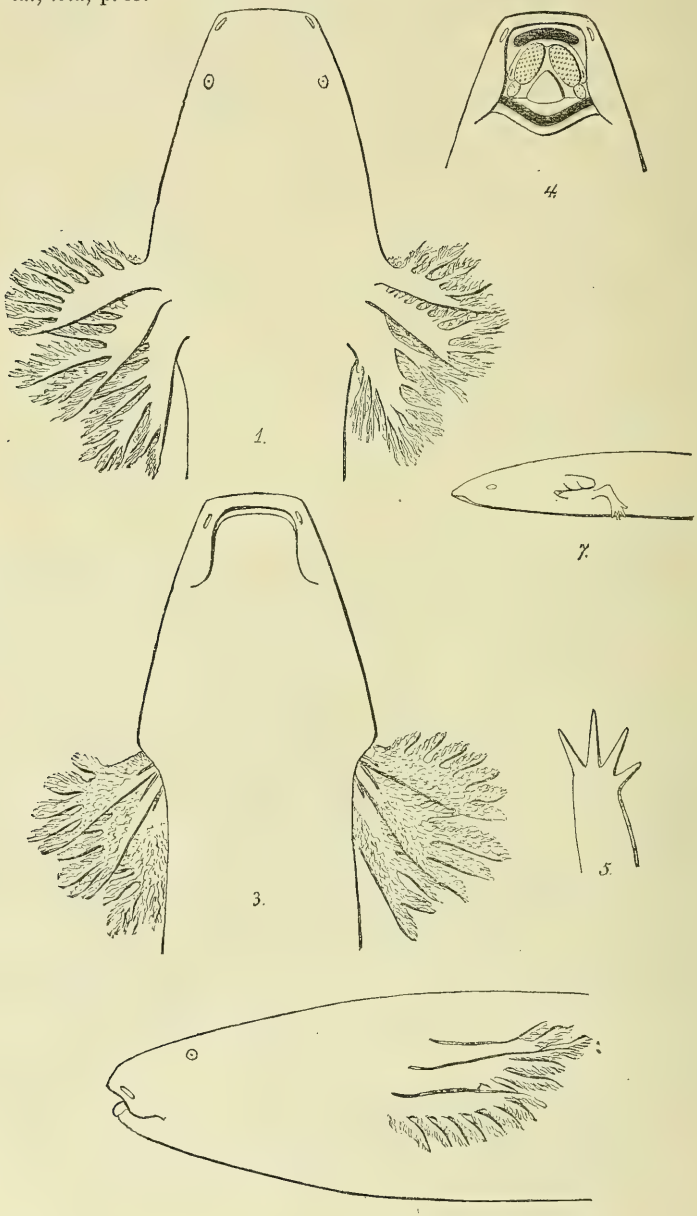

FIG. 57. *Siren lacertina.* No. 12593. Wilmington, N. C. ⅓. No. 7, young with abortive branchiæ.

* Plates 9, figs. 1–3; 13, fig. 6; 43; 44; 46, fig. 5; 49, fig. 5.

In general form this animal is quite elongate, and the tail is considerably shorter than the body, measuring one-half of the length of the head and body together. The head is a longer or shorter oval in outline, and the end of the muzzle is rounded, truncate, and projects beyond the lower jaw to a moderate degree. In profile it is depressed, and the line of the front gradually descends from behind. The fore limb is short, measuring just half the distance between its anterior base and the end of the muzzle.

The eyes are very small, and are covered by a thin epidermis or cornea. They are situated just one-third the distance between the end of the muzzle and the base of the anterior external branchia. The upper lip is pendulous at the sides of the mouth, overlapping the lower lip. The latter is free and pendulous at the sides, and is bounded below at the base by a deep groove, which may or may not be continuous round the entire chin. Thus it is complete in seven specimens and incomplete in eighteen. Both conditions are seen in specimens from the same locality, as, for instance, those from Riceborough, Ga., and Matamoros, in Tamaulipas. The external nares are well separated from each other, and are short transverse slits.

The superior horny sheath is quite short, covering only the premaxillary bone. It has a sharp edge, and is black in color. The lower sheath is much longer, covering the entire edge of the dentary bone. It is also sharp-edged and black. The tooth patches vary in proportions in different individuals. They are distinct from each other, but are in contact anteriorly and diverge posteriorly. The teeth are small and acute, and are arranged in numerous transverse rows in each patch. In adult individuals the patches have an oval outline, but their width varies, and in some others and in immature examples they are more or less linear. Thus in one specimen from Matamoros the vomerine teeth are reduced to a line on each side, the two forming a Λ. In one from Georgia the same arrangement occurs, but in a second from the same locality, and in every other respect similar to it, the teeth are in a wide patch. In two others the patch is intermediate in characters. The surface of the tongue is smooth, not displaying plicæ or large pappillæ. It occupies nearly the entire floor of the mouth. The internal nostrils are each a hole at the exterior side of the parasphenoid patches of teeth, at the point marking the posterior third of their length.

The fingers are moderately elongate, and are perfectly free from dermal web or border. Their lengths are in order, commencing with the shortest, 5–2–4–3. The third and fourth are sometimes of equal length.

The branchiæ, when fully developed, form a bipinnate frame-work, to which the ultimate fibrillæ are attached; that is, the primary stem sends a row of secondary branches downwards on each side, and these again ternary branches on each side. To the under side of these the fibrillæ are attached. They are quite short. The entire branchia is short and not produced at the extremity, as is the case with *Necturus*

punctatus and larvæ of Amblystoma. In Proteus the secondary branches are also present. The fibrillæ in Siren present different conditions, perhaps dependent on the character of their environment as to the abundance of water, etc., and indicating different degrees of functional efficiency. I have discussed this question under the head of the family Sirenidæ.

The body is rounded, subquadrate in section, and displays an indistinct median dorsal groove. The transverse grooves are distinct on the sides and nearly meet on the belly, but are not distinct on the back. They vary from thirty-one to thirty-seven in number. The larger specimens generally have thirty-six and thirty-seven grooves, while smaller ones frequently have only thirty-one and thirty-two. The specimens with thirty-three, thirty-four, and thirty-five are of medium size; but a full-sized one from Georgia (No. 4535) has thirty-two, and a small one from South Carolina (No. 10514) has thirty-four. It was on specimens presenting the characters of the smaller individuals above mentioned that the *S. intermedia* of Leconte was proposed. I can not distinguish it from the ordinary form. The skin is everywhere perfectly smooth. The tail is compressed from the base to the extremity, and for its distal half is quite thin. It has a strong dermal fin above and below. It commences above opposite to the anterior extremity of the vent, and below about one-fourth the length of the tail posterior to the vent.

The branchial fissures, as remarked in the discussion of the supposed retrograde metamorphosis of Siren, may be one, two, or three, on one or both sides. In a series of small specimens from South Carolina (No. 14111) the fissures are as follows: 2–1, 3–2, 2–2, 2–2. In a similar series from Georgia (No. 4535) they are 2–2, 3–3, 2–2 larger than last; 2–3 same size as last, and 3–3 fully grown.

Measurements of No. 8349.

	M.
Total length	.714
Length of head and body	.470
Length to axilla	.082
Length to first branchia	.055
Length to line of canthus of mouth	.019
Length to line of eye	.014
Length of fore-leg from axilla	.0385
Length of humerus from axilla	.019
Length of cubitus	.016
Width between nostrils	.0165
Width between eyes	.023
Width of head	.045
Expanse of fore limbs extended	.114
Depth of tail at middle	.065

The general color is a dark lead-color, usually darker above than below. There is in some specimens a yellow band, with irregular or badly defined outline, extending around the muzzle and upper lip to the base of the anterior branchia. In some specimens this band includes the chin;

in others it is present on the cheeks only. In a fully grown specimen from Matamoros, Tamaulipas, this band is continued along the side for one-half the length, beyond which point it is represented by scattered yellow dots. A second similar badly defined band originates at the lower edge of the axilla, and extends along the inferior part of the side for two-thirds the length of the superior band. These bands have the position of those seen in the *Pseudobranchus striatus*. In a second equally large specimen from Matamoros these bands are wanting.

The geographical range of the *Siren lacertina* is the best measure of the extent of the austroriparian region of North America. It appears in the middle of eastern North Carolina, and extends thence throughout the southern Atlantic and Gulf States through Texas to the west side of the Rio Grande, where it ceases. Northwards it ascends the Mississippi Valley proper as high as Alton, Ill., and eastward in the Wabash basin, in Indiana, to Lafayette (Coulter), and the White River (Jordan).

Siren lacertina Linn.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8349	1	Neuse River, N. C		H. W. Welshet	Alcoholic.
8537	1	Columbia, S. C	Mar. —, 1876	E. E. Jackson	Do.
9192	1	Mount Carmel, Ill	July 22, 1877	Robert Ridgway	Do.
9317	1				Do.
9193	4	Oakley, S. C	May 1, 1877	F. W. Hayward	Do.
10514	1	Columbia, S. C	1878	E. E. Jackson	Do.
10852	1	Upson, Texas	1880	Albert Turpe	Do.
10853	1	do	1880	do	Do.
7067	1	Charleston, S. C		Charleston Academy	Do.
5040	2	Georgia	Feb. 1, 1861	Dr. W. L. Jones	Do.
4535	4	Riceborough, Ga		do	Do.
5201	1	Grand Coteau, La	Feb. 4, 1861	St. Charles College	Do.
4048	4	Matamoros, Mexico		Lieut. B. Couch, U. S. A	Do.
10313	1	Oakley, S. C	May 11, 1879	F. W. Hayward	Do.
5960	1	Matamoros, Mexico		Lieutenant Couch	Do.
12593	1	Wilmington, N. C		Donald McRae	Do.
7048	1	Gulf State		C. B. Adams	Do.
	2	San Diego, Tex	June —, 1888	W. Taylor	Do.

GENERAL SERIES.

7001	1	(?)			Alcoholic.
4535	2	Riceborough, Ga		Dr. W. L. Jones	Do.
4048	2	Matamoros, Mex		Lieut. B. Couch, U. S. A	Do.
7018	4	(?)			Do.
7009	3	Georgetown, S. C		Cheston	Do.
7142	3	Prairie Mer Rouge, La			Do.
10875	1	Oakley, S. C			Do.
10855	1	(?)			Do.
10858	1	(?)			Do.
10859	1	(?)			Do.
10866	1	Oakley, S. C	Mar. 13, 1878	F. W. Hayward	Do.
10857	1	(?)			Do.
10860	1	(?)			Do.
10861	1	(?)			Do.
10854	1	(?)			Do.
10856	1	(?)			Do.
10862	1	(?)			Do.
10874	1	Oakley, S. C			Do.
10871	1	do			Do.
10869	1	do			Do.
10872	1	do			Do.
10873	1	do			Do.
10867	1	do	Mar. 13, 1878	F. W. Hayward	Do.
10313	3	do	May —, 1879	do	Do.
10870	1	do			Do.
10428	1	do	May —, 1880	F. W. Hayward	Do.
9560	2	do	Mar. —, 1878	do	Do.
10868	1	do	Mar. 13, 1878	do	Do.

PSEUDOBRANCHUS Gray.

Ann. Philos., 1825, p. 216; Cat. Batr. Grad. Brit. Mus., 69; Boulenger, Cat. Batr. Brit. Mus., ed. II, 1882, p. 87.

Digits three. Jaws with horny sheath. Tongue free in front; eyes distinct. External branchiæ three. Parasphenoid teeth in two rows, united in front, forming a longitudinal Λ. One branchial fissure on each side.

The reduced number of digits and of branchial fissures are the characters which separate this genus from Siren. The peculiarities found in the branchiæ are shared by the latter genus. But one species of Pseudobranchus is known.

PSEUDOBRANCHUS STRIATUS Leconte.

Gray, Ann. Philos., 1825, p. 216; Gray, Cat. Batr. Grad. Brit. Mus., ed. I, p. 69; Boulenger, Cat. Batr. Grad. Brit. Mus., ed. II, 1882, p. 87.

Siren striata Leconte Ann. Lyc., N. Y., 1824, p. 52, Pl. 4; Tschudi, Batr., p. 98. Holbr., N. A. Herp., V. p. 109, Pl. 36; Dum. & Bibr., Pl. 96, fig. 1.

This species is much smaller than the *Siren lacertina*, and differs from it in a good many characters. The body is cylindric, and the tail measures two-thirds the length of the head and body and a little more. The head viewed from above has a rather narrow oval outline, and its extremity is rounded without truncation, or sometimes acuminate. In profile the front descends regularly to the end of the muzzle, which overhangs the mouth by a little. The eyes are quite distinct, though small, and are on the border of the head when viewed from above, but have more upward than lateral direction. The mouth is very small and does not extend so far posteriorly as the anterior border of the eye. The upper lip is pendulous, overlapping the lower, so as to reduce the mouth when closed to a small aperture on the middle line in front. The lip of the lower jaw is not recurved, and there is no groove passing around the chin. The external nostrils are in the upper lip, not very near its edge, but they are not visible from above. The distance between them is three-quarters the length of that between the eyes.

The parasphenoid series of teeth are but little in contact in front, and each one consists of two or three rows. They extend anteriorly near to the premaxillary and posteriorly to opposite the rictus oris. The choanæ are round, and are at the external side of the parasphenoid series, one-fifth the distance anterior to their posterior extremity. The tongue is narrowed and acuminate in front, and its free portion is relatively longer than in the *Siren lacertina*.

The branchiæ have not the same character as those of the *Siren lacertina*, being tripinnate on the external side only. The first is much shorter than the second, which is shorter than the third. The single fissure is below the base of the second. I have not found a second fissure in this species, nor have I found this one closed in individuals with

aborted branchiæ, as occurs in the case of the other two in *Siren lacertina*. The limbs are short and weak, and their length enters that from their base to the end of the muzzle two and a half times. The lateral toes are generally of equal length, and the median one is a little longer. All are acute at the extremity.

The skin is entirely smooth, and there are thirty-four transverse grooves between the axillæ and the vent. The cross-grooves are continued on the tail, so as to be distinct for two-thirds of its length. The tail is but little compressed for the proximal three-fourths of its length, the vertical section being vertically oval or lenticular posteriorly. A narrow dermal free border commences at the end of the proximal fifth of its length and increases in width to the tip, but is never as wide as in the *Siren lacertina* and in the Necturus and Cryptobranchus. The inferior dermal border is less extensive, existing only on the terminal fifth of the tail. The tail is relatively longer than in the *Siren lacertina*. The follicles of the skin are large, and so close together as to give the surface a reticulated appearance. There are no distinct mucous pores of a deeper character.

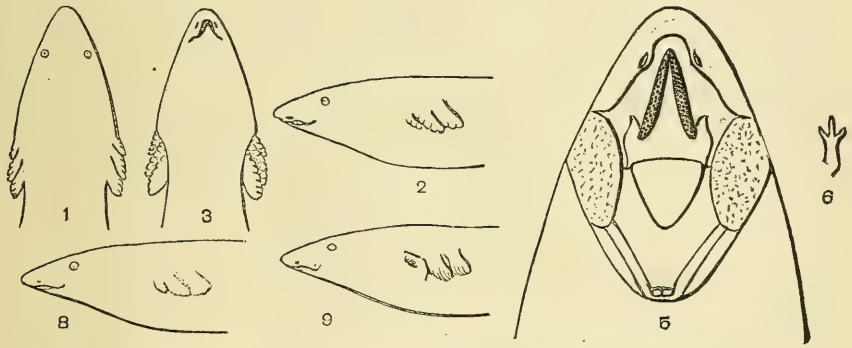

FIG. 58. *Pseudobranchus striatus*; No. 7010; twice natural size; fig. 5, xix.

Measurements of 5051.

	M.
Total length	.152
Length to end of vent	.087
Length to axilla	.013
Length to first branchia	.010
Length to eye	.0025
Length to rictus oris	.002
Length of fore-leg	.004
Length of fore-foot	.0015
Width of head (greatest)	.006
Width between eyes	.003
Width of extended fore limbs	.015

The general color is chocolate-brown, more or less tinged with lead-color, especially when the epidermis is fresh. A rather wide yellow band commences at the last branchia and extends along the side to near the end of the tail. It is continued, but less distinctly, from the branchiæ forwards to the end of the muzzle. A narrower band com-

mences just below the branchiæ and extends along the side of the abdomen parallel with the superior band, to nearly opposite the vent. In some specimens a similar band extends from the vent along the median line below to the end of the tail, but this is frequently wanting. More frequently the dermal keel and border on the superior edge of the tail is yellow, and this color is sometimes prolonged on the median line of the back for the posterior half or more of its length. The belly has rather large, more or less longitudinal yellow spots; and the ground color between the lateral bands is similarly but less coarsely spotted, except on the tail, where the spots are dense. The fore limbs are yellow, with a brown tinge.

The branchiæ of this species display partial or entire abortion in a larger proportion of individuals than in the *Siren lacertina*. An epidermal sheath may inclose the fibrillæ on the external side only, or on the external and internal sides. In ten specimens five have the epidermal covering on both sides, three have the fibrillæ free at the lower edge of the branchia, and in two the fimbriæ are free on the entire posterior face. Sometimes the first branchia is inclosed in a distinct sheath from the other two, and sometimes all are distinct. The insheathing membrane may be continuous at the inferior edge of the branchia with the epidermis of the throat. In this case a small fissure remains, corresponding with the one on the pharyngeal wall.

This species is so far only known from Georgia and Florida. From the latter State I have received it from Volusia.

Pseudobranchus striatus Leconte.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
7010	5	.....	1855	.....	Alcoholic.
5051	4	Georgia	Feb. 1, 1851	Dr. W. L. Jones	Do.
7020	1	.....	.....	.....	Do.
	10				

SALIENTIA.

Laurenti, 1768.

Anura Duméril, 1804.

OSTEOLOGY.

Supraoccipital, basioccipital, intercalary, supratemporal, and postfrontal bones wanting. Frontals and parietals connate; prefrontals present; nasals wanting or rudimental. Vomers and palatines present, distinct from each other, the latter inclosing the internal nares and joining the pterygoids. Maxillaries, premaxillaries, and ethmoid present.

Vertebral bodies undivided, separate proatlas wanting. Vertebræ very few, on account of the anterior attachment of the pelvis and the disappearance of some and fusion into a single styloid bone (the urostyle) of others of the vertebræ posterior to the point of attachment. Ribs very short or wanting.

Coracoid, clavicle, and scapula osseous, well developed; procoracoid, epicoracoid, and suprascapula cartilaginous. Sternum present, entirely posterior to the coracoids. No præsternum nor interclavicle, but frequently a median element anterior to the clavicles called the omosternum.

Pelvis consisting of the usual three elements, the inferior pairs closely united, forming a compressed body without obturator foramina. Ilium subcylindric, very elongate.

Humerus without distinct head proximally, but with an epiphysis. Distally a globular condyle. Other long bones with epiphyses at both extremities. Astragalus and calcaneum elongate, forming a limb segment. Carpal bones well developed, some of them, especially of the distal series, confluent. Tarsals of the distal series much reduced in size and numbers. (Plates 47, 59, etc.)

The auditory appendages differ from those of the Urodela, Proteida, and Trachystomata in their greater complexity. There is a cavum tympani or external ear and a series of ossicles and cartilages extending through it, structures all wanting to the orders mentioned. The stapes is, like that of those orders, an oval disk, which has no continuous process, but gives origin at its middle to the stapedius muscle. Immediately in front of it there arises an osseous rod, the interstapedial bone. Its base is cartilaginous, and is expanded with concave surface fitting the convex surface of the skull. This rod terminates at the superior interruption of a flat annular cartilage (*Annulus tympanicus*), which lies on the quadrate cartilage and over the concavity formed by its forwards flexure. The mesostapedial cartilage is attached by a point on its interior face to the apex of the interstapedial, somewhat as an anther of a flower is attached to its filament. Its superior portion is shorter, and is connected with the quadrate above by the mesostapedial ligament. Its inferior portion is more or less expanded distally. Its external face is flat, and is applied to the inner side of the disciform epistapedial. The latter is applied like a lid to the annular cartilage already mentioned. The mesostapedial then occupies a place between the annular and the epistapedial cartilages. The membranum tympani fits closely over the latter. (Plates 49–50.)

The hyoid apparatus differs materially from that of the orders mentioned. It can only be understood by reference to its development from the larval stages. There are present in the larva a ceratohyal on each side and a first basibranchial, as in Urodela. The hypohyal is connate with the former. Posterior to the basibranchial, two lateral cartilaginous plates, the "hyobranchials," meet on the middle line.

From the external edge of each of these four cartilages the ceratobranchials radiate. The fourth or posterior is frequently confluent with its hyobranchial. (Plate 51, fig. 1.) With the completion of the metamorphosis the basi- and hyobranchials fuse into a single piece, and the ceratobranchials unite with the same plate, excepting the fourth, which, becoming ossified, forms the only true bone of the region. In some types the ossification becomes more extensive, as in Cyclorhamphus; (Plate 76, fig. 10.) Sometimes the third ceratobranchial is ossified, as in Alytes (*l. c.*, fig. 2) and Hemisus (*l. c.*, fig. 18).

The digits of the Salientia are apparently four anteriorly and five posteriorly; there is generally a rudimental digit, in addition, on the inner side of each foot. The thumb is especially well developed in the Hylid genus, Hypsiboas Wagl.; (Plate 72, fig. 26.) The inner digit of the posterior foot, or the internal hallux, as it is called, has three elements in some of the Ranas (see Plate 65, *Rana catebesiana*), while in other forms the digit is principally represented by a large flat phalange. This is called the spur or metatarsal tubercle in works on the subject, and it is sometimes incorrectly referred to the tarsus.

The carpus of the Salientia has but two proximal elements, the intermedium not being distinct. There is a large centrale, which forms part of the inner border of the palm. The order is further characterized (except in the Discoglossidæ and the Aglossa, *q*, *v.*) by the fusion of the fourth and fifth carpalia into a single element, the unciforme. The other three carpalia are distinct, and the first is frequently displaced to form the base for the metacarpus of the thumb. The large size of the astragalus and calcaneum have been already referred to. The tarsus is further peculiar in the absence of intermedium and centrale and the absence of tarsalia, except a rudiment or two near the inner part of their usual position. (Plate 73.)*

INTEGUMENT.

The slight attachment of the integument to the muscles is a well-known feature of the Batrachia Salientia. The manner of their attachment presents many varieties in the different groups. It is as follows: A transverse partition of connective tissue holds the integument along the acromials and another along the coracoids; a longitudinal band on each side of the back (frequently marked externally by a glandular fold) and one below it on each side of the abdomen; a band or line along the hinder inferior face of the thighs, extending nearly to the popliteal region, and a delicate one along the upper hinder face of the same, from the groove between the superior and posterior muscles.

* These results were sent in to the Secretary of the Smithsonian Institution February, 1887. Through the delay in publication they have been anticipated by an admirable paper on the carpus and tarsus of Salientia by Mr. G. B. Howes, Proceeds. Zool. Soc. London, 1888, p. 141 (March).

The attachments are similar to the last in the Dendrobatidæ, in Eupemphix, and in Brachycephalus. In *Engystoma ovale* the lateroventral line is broad, or composed of several series of fibers and laminæ, and in *E. carolinense* it is composed of two septa. In Pseudophryne the dorsolateral septum, as well as the last mentioned, is widened; Phryniscus is similar, except that the dorsolateral is narrower posteriorly, but, rapidly widening, meets its mate on the nape, forming a broad transverse attachment. In *Atelopus lævis* the integument between the dorso- and ventrolateral septa is attached, forming a broad lateral adherent band. In *Rhinophrynus dorsalis* this lateral attachment is carried so far as to leave only narrow free dorsal and ventral regions, while it is further peculiar in wanting the coracoid septum, as in Discoglossus and Xenopus. Epidalea, Bufo, and Peltaphryne, in their numerous species, add to the raniform structure the attachment of the whole dorsal integument. The following table exhibits the other attachments.

Belly broadly free, very narrow lateroventral attachment: *Bufo hæmatiticus, leschenaultii.*

Belly broadly free, broad lateroventral attachment: *B. americanus, lentiginosus, cognatus, chilensis, columbiensis, vulgaris, naricus, vallicops.*

Belly broadly free, posterior fourth or fifth abdomen attached: *gracilis, compactilis pantherinus.*

Lateroventral attachment very broad, leaving but narrow free abdominal space: *B. coniferus, quercicus, intermedius, punctatus, alvarius, diptychus.*

Ventral integument atttached: *B. coccifer, insidior, viridis, kelaartii* (posterior half attached).

A considerable variety is exhibited by the families of the Arcifera. In the genera of Discoglossidæ examined (Discoglossus and Bombinator) the attachments are as in Ranidæ, except the absence of the coracoid septum, as in Xenopus. On the contrary, in the Scaphiopodidæ, the integument is more or less entirely adherent above and below. The greater number, including the typical forms of Hylidæ, add to the ranid arrangement a close areolar attachment of the abdominal skin, while it is characteristic of many species of Cystignathidæ to possess one or two transverse simple posterior abdominal septa. For the many variations and exceptions, see under the respective families.

Of the Aglossa, Xenopus lacks the coracoid and inferior femoral attachments; there is a double or treble, but not wide, lateral adhesion low down, which may be a combined dorsolateral and dorsoventral, or broad dorsoventral only. In Pipa all the attachments are wanting, except two closely approximated lateral lines and a superior posterior and anterior inferior femoral.

VISCERA.

With regard to the differences in the arrangement and structure of the internal organs a great deal remains to be observed. Henle (Anatomie des Kehlkopfes) points out some inconsiderable differences in

the form of the cartilages of the larynx. The size and number of the pulmonary cells vary considerably. Among Hylidæ, especially those species with a loud voice, they are fewer and larger than in Discoglossidæ and Scaphiopidæ. The forms of the sinus, auricles, ventricle, and bulbus arteriosus, the three aorta bows, of which the median form the aorta roots, etc., appear quite identical externally in the Discoglossus, Scaphiopus, and Phyllomedusa. Internally the two former present the known characters of the Anura, *i. e.*, the union of the distinct ducts of the first (pulmonary) and second (aortic) aorta bows throughout much of their length, the separate union of the two former and continuance on the left side of a high free septum of the bulbus, till they are finally turned over the right division toward the right, and have a common issue from the ventricle. A conic pocket valve is at the origin of the bifurcation of the ductus communis of the second and third aorta bows, but none in any part of the course of the pulmonary.

The general characters of the venous system have been described on page 10. The researches of Hochstetter* and Howes† have shown that the cardinal veins do not disappear in all of the Salientia. Hochstetter in fact believes "that the vena cava inferior, instead of being throughout its whole extent a primarily independent vessel, is a compound structure, the product of a fusion between a late-formed hepatic vessel and one or both of the posterior cardinal veins" (Howes). In Batrachia the postrenal portions only of the cardinals go to form the vena cava posterior, and the prerenal portions disappear or remain as azygos or hemiazygos veins. Their persistence is shown to be frequent in the Discoglossidæ, in Bombinator (Hochstetter Howes), Alytes (Howes), and Discoglossus (Howes). It is wanting in other Salientia, including the Aglossa, Pelodytidæ, and Pelobatidæ (Howes).

The general character of the brain in the Salientia may be gathered from Plate 56. As I omitted, by an oversight, to refer to the characters of this region in my anatomical introduction (pp. 1–12), I introduce here some remarks on its peculiarities in the Proteida, Urodela, etc., as well. In the Proteida (Necturus, fig. 1) the thalamencephalon is exposed by the non-production posteriorly of the prosencephalon. In Urodela generally (Plate 40) and in Salientia it is moderately exposed; in Cæciliidæ (Plate 56, fig. 3) it is generally concealed. In all the tailed forms there is a large vascular "supraplexus" protruding from between the hemispheres. Posterior to this the epiphysis appears; it is small in all the orders. The hypophysis is on the other hand large. The cerebellum (epencephalon) is a mere commissure in the entire class. The diacœlia, mesocœlia, and metacœlia are only separated by slight constrictions of their walls. The metacœlia is covered in the Salientia by a triangular choroid plexus (Plate 56 *p. c.*). In Proteida, Urodela, and Trachystomata the olfactory lobes (rhinencephala) are distinct; but

* Morphologisches Jahrbuch, 1887, p. 119; Anatomischer Anzeiger, 1887, 517.
† Proceed. Zoöl. Soc. London, 1888, p. 122.

in the Salientia they are confluent with each other. In Xenopus (Plate 54, fig. 18) the thalamencephalon is more entensively exposed than in other Salientia.*

The form of the liver does not differ from the usual type in any of the various species examined, except in the Firmisternia. While most Salientia have this organ divided into three lobes, there are but two in the Brevicipitidæ, Engystomidæ, and some of the Phryniscidæ. In the alimentary canal there appears to be little variety in important points. The stomach has generally a more longitudinal position than among Bufoniformia, except among Scaphiopidæ and in Ceratophrys, where it is equally transverse. No intestinal valves were observed in Pelobates, Hyla, Phyllomedusa, Ceratophrys, but a strong pyloric muscular constriction in Pleurodema, and one at the extremity of the small intestine in *Cystignathus pachypus*. (Plates 53–55.)

The testes are single in examples of all the types examined, and not strictly symmetrical; they are variously situated with reference to the kidneys. Thus in *Ranoidea aurea*, and *Trachycephalus lichenatus* they are elongate and at the middle of the length of the kidneys, while in *Hypisboas boans* and *Scytopis venulosus* they are oval, and one or both at the anterior extremity of the latter. In *Phyllomedusa scleroderma* they are more than half the length of the broad kidneys, the right originating at the anterior extremity of the latter, the left but little behind it. Both have their posterior apices in close contact at the posterior fourth of the length of the kidneys, which are in close connection for their posterior third. In Discoglossus the testes are oviform, well separated, and anterior, and during the breeding season attain a remarkably large size. During the same in *Cystignathus pachypus* they are not materially enlarged, are elongate, and only in contact with the kidneys for a small posterior part of their length.

The ovaries and oviducts do not essentially vary among the Salientia When the latter are fully occupied by eggs in an advanced stage they are folded, but differently in the same species. The oviducts are remarkably slender in *Hyla nasuta* (Litoria Günther), and in *Scytopis* the fontanelle is on each side behind the partial diaphragm, at the superior anterior outer angles of the liver. In several young female specimens of *Ranoidea aurea* of the size of *Rana silvatica*, in which the frontoparietal fontanelle is not closed, the oviducts do not extend farther anterior than the ovaries; in adults, with the cranium complete, they have the usual extent. In *Cystignathus ocellatus* the "uterine" sacs at the exit of the oviducts are of great size, and at certain seasons distended with an albuminous gelatine, when they present several convolutions. In spirits they occasion the presence of a large convoluted mass of coagulum.

* For descriptions and figures of brains of Urodela, Proteida, and Trachystomata, see Osborn; (Amphiuma), Proceeds. Phila. Acad., 1883, p. 177; (Cryptobranchus and Rana), *l. c.*, 1884, p. 262; *Corpus callosum*, Morphologisches Jahrbuch, 1886, pp. 223, 530; also Wiedersheim, Anatomie der Gymnophionen, Jena, 1879.

REPRODUCTION.

The Salientia have, in temperate climates at least, an annual period of reproduction, which occurs in the spring. The male is without intromittent organ, and fertilization is accomplished by the discharge of the spermatic fluid of the male on the eggs as they leave the body of the female. In order to accomplish this effectually the male attaches himself to the female by seizing her with his anterior limbs. In the greater number of the Salientia the embrace is round the axillæ, but in the Discoglossidæ, which approach nearest the salamanders in their anatomy, the embrace is, as in those animals, round the loins. In the salamanders it is, however, the hinder feet that seize the female, and not the arms. Among other families the genera Cultripes, Pelobates, and Pelodytes also seize the female around the waist. It is probable that this will be found to be the case in some other genera not yet observed.*

The species of Arcifera exhibit peculiar structures during the breeding season; either an extension of the natatory membrane, or the development of corneous plates or spurs, as aids to prehension. There is much variety and efficiency displayed in this point (except in Bufonidæ), in especial contrast to the apparent absence of all but the weakest modifications among the Ranidæ. This is in compensation for the structure of the sternum, whose lateral halves, being movable on each other, offer a slighter basis of resistance for the flexor and extensor muscles of the fore limbs.

In the Discoglossidæ, Bombinator extends the natatory membrane in the male, but does not develop horny plates. In Discoglossus two file-like oval plates cover the superior surface of the short second digit and the tubercle-like first or thumb, which is here developed as in no other anurous batrachian. Dermal rugosities on the upper and under surfaces, including the gular region, are armed with corneous tips, as in Telmatobius. No peculiarity has been noticed in Alytes. The Asterophrydidæ are unknown as to this point.

In Pelodytes file-like plates are developed one on the second and one on the third digit, one much larger on the fore-arm, one slightly smaller on the inside of the humerus, and a small one on each side of the breast.

Among Scaphiopidæ the American species develop elongate laminæ on the superior inner face of the inner (second), third, and even fourth digits. No peculiarities are recorded as appearing in the European species. Many Hylidæ—Agalychnis, Trachycephalus—develop a corneous shield on the inner superior aspect of the inner metacarpal, which is prolonged on the digit.

While no appendages of the season have been observed in some Cystignathidæ, in several genera two acute spurs appear on the superior

* On account of this difference MM. Thomas and Delisle have proposed to divide the Anura into two groups, naming them the Alamplexes and Inguinamplexes. See Journal de Zbologie, VI, 1877, p. 472.

aspect of the thumb and more rarely spur-like tubercles on the breast; the body is sometimes shielded with hardened points on the rugosities, or the lip surrounded by an arched series of corneous rugæ. In the *Leptodactylus pentadactylus* Laur. a huge acute process of the metacarpal of the thumb, Plate 73 (fig. 32), projects inwards. Its apex is covered by a horny cap, and it is a formidable grappling-hook to aid the male in retaining his hold. There is added to this in the same species a horny plate on each side of the thorax of the male, from which project three acute points. With these fixed in her back and the thumb spikes in her breast the females can not escape. Structures like this do not appear in the Firmisternia. Here the inferior elements of the scapular arch abut against each other, so that the thoracic cavity does not contract on pressure, and the possibility of the male retaining a firm grip on the female is thereby greatly increased. In the *Cystignathus pachypus* the males exhibit a permanent enlargement of the brachium, dependent on largely developed anterior and posterior alæ of the humerus. (*Vide* Günther, Ann. Mag. N. H., 1859.)

The various ways in which the eggs are deposited by the female are expressed in the following table from Boulenger. I add the peculliar habit of the genus Dendrobates, as observed by H. H. Smith in Brazil.

I. The ovum is small and the larva leaves it in a comparatively early embryonic condition.

A. The ova are laid in the water.

Probably the majority of Batrachians; all European forms except *Alytes*.

B. The ova are deposited out of the water.

a. In holes on the banks of pools, which become filled with water after heavy rain, thus liberating the larvæ.

Leptodactylus ocellatus L.; *L. mystacinus* Burm.; *Paludicola gracilis* Blgr.*

b. On leaves above the water, the larvæ dropping down when leaving the egg.

Chiromantis rufescens Gthr. ;† *Phyllomedusa iheringii* Blgr.

II. The yolk-sac is very large, and the young undergoes the whole or part of the metamorphosis within the egg; at any rate the larva does not assume an independent existence until after the loss of the external gills.

A. The ova are deposited in damp situations or on leaves, and the embryo leaves the egg in the perfect air-breathing form.

Rana opisthodon Blgr. ; ‡ *Hylodes martinicensis* Dum. & Bibr.§

B. The ova are carried by the parent.

a. By the male.

a. Round the legs; the young leaves the egg in the tadpole state.

Alytes.‖

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* Hensel, Arch. f. Naturg. 1867, pp. 124, 129, 138.

† Buchholz, Mon. Berl. Ac. 1875, p. 204, and 1876, p. 714, Pl. II.

‡ Boulenger, Trans. Zool. Soc., XII, 1886, p. 51.

§ Bello y Espinosa, Zool. Gart., 1871, p. 351; Bavay, Ann. Sc. Nat. (5), XVII, 1873, art. 16; Peters & Gundlach, Mon. Berl. Ac. 1876, p. 709.

‖ Demours, Mém. Ac. Sc. Paris, 1741, p. 13; De l'Isle du Dréneuf, Ann. Sc. Nat. (6), III, 1876, art. 7.

β. In a gular (the vocal) sac; the young is expelled in the perfect state.

*Rhinoderma.**

b. By the female,

a. Attached to the belly.

Rhacophorus reticulatus Gthr.†

β. Attached to the back; the young completes its metamorphosis within the egg.

Pipa.‡

γ. In a dorsal pouch.

aa. The young leaves the pouch in the tadpole state.

Nototrema marsupiatum Dum. & Bibr.§

bb. The young leave the pouch in the perfect state. *Nototrema testudineum* Esp.;‖ *Opisthodelphys ovifera* Weinl.‖

The species of Dendrobates have the peculiar habit of carrying the young from place to place in search of water. The tadpoles resemble those of Rana or Bufo, and attach themselves by the mouth to the back of the parent. Whether the eggs are carried in this position is not known.¶

The larvæ of Salientia have been divided into two groups by Lataste, the Mediogyrini and the Laevogyrini.** In the former the external branchial orifice is on the median line of the inferior surface; in the other it is on the left side. To the former division belong the Discoglossidæ; to the latter all remaining Salientia, except Aglossa, where there are two spiracula, one on each side (Amphigyrini Heron-Royer).

In the stage which immediately follows the separation from the egg the tadpoles of Salientia possess one or two peculiar sucking disks on the under side of the head behind the position of the mouth. Their form differs (Plate 78) widely in different genera of Anura, and will afford a valuable means of identifying the larvæ. In *Discoglossus pictus*, the adhesive organ behind the mouth, is hemispherical, with a V-shaped groove on its surface, the V opening forward. In *Pelobates fuscus* the adhesive organ is V-shaped, with a V-shaped groove on its surface, and the limbs of the whole organ extending forward to embrace the angles of the mouth. In *Bufo vulgaris* the organ is V-shaped, with a V-shaped groove, and the limbs of the V come into contact with the angles of the mouth. In *Bufo viridis* the organ is crescent-shaped, not in contact with the mouth, but a little behind it, as in Discoglossus, and with a widely open V-shaped groove. In Bombinator, Rana, and Hyla there are two dis-

* Jimenez de la Espada, Ann. Soc. Esp. Hist. Nat., 1, 1872, p. 139; Spengel, Zeitschr. wiss. Zool. XXIX, 1877, p. 495; Howes Proceeds. Zool. Soc. London, 1888, p. 231.

† Günther, Ann. & Mag. Nat. Hist. (4), XVII, 1876, p. 379; Ferguson, *op. cit.*, XVIII, 1876, p. 357.

‡ Fermin, Développement parfait du mystère de la génération du fameux Crapaud de Surinam; Maestricht, 1765.

§ Boulenger, Cat. Batr. Ecaud., 1882, p. 417.

‖ Weinland, Arch. f. Anat. Physiol., 1854, p. 449.

¶ Kappler, Das Ausland, 1885, p. 858; Smith, American Naturalist, 1888, p. 182.

** The family terminations "idæ" given to these divisions by Lataste are inappropriate, as they do not represent families.

tinct oval adhesive organs on either side of the median line, with traces of a V-shaped groove connecting them, and both are behind the mouth. In *Rana agilis* there are two separate adhesive organs, one on each side, behind the mouth, and each has a slight depression on its posterior border. In *Hyla arborea* there are two circular adhesive organs close to the angles of the mouth at either side. In *Bombinator igneus* there are two oval adhesive organs behind the mouth, which are in close contact, and later on fuse into a single organ, both having an oval depression in the center. The following observations have been made on them by Professor Ryder (American Naturalist, 1888, p. 263). (See Plate 76.)

These organs are clearly for the purpose of enabling the young larvæ to attach themselves to various fixed bodies in the water, such as weeds, the gelatinous egg-strings and masses from which they have been hatched, etc. They are thus afforded support and prevented from sinking into the ooze to smother, and their enemies thus also doubtless find them a less ready prey. These disks are also shown by Thiele not to be of the nature of suctorial organs, but are glandular, being formed wholly of thickened epidermis, which is elevated, its cells becoming lengthened or columnar. There is no muscular suctorial apparatus developed in connection with them, and they are secretory, secreting a sticky mucus or slime, which serves to fasten the young tadpole to its resting-place. That an actual secretion is formed is proved by the fact that a slimy thread of secreted matter is drawn out from the disk if the young tadpole be forcibly withdrawn from its support. They are specifically larval organs, and persist only for one to two weeks after hatching. They may be compared to the "balancers" found behind the mouth in the larva of Amblystoma. In Tritons stalked suckers are said to be present, which Balfour compares to the sessile "suckers" of larval toads and frogs. Ryder observes that he cannot see how it is possible to homologize the sucking disk of larval gar-pikes with the adhesive organs in larval Batrachians, because in the former the disk is in front of the mouth and in the latter it is usually quite behind the mouth; only in one case (Hyla) are the suckers found near the angle of the mouth. The larva of Xenopus has two long barbels at the side of the head from the sides of the upper lip. But in this last case even it is doubtful if there is any homology with the "suckers" of other larval Anura. There certainly can not be any homology between the organ of the gar-pike's larva and that of young toads and frogs, though it is probable that these organs in the latter are truly homologous with the "balancers" of the larvæ of salamanders of the type of Amblystoma and Triturus.

Thiele further shows that, inasmuch as these structures are glandular, with no muscular apparatus, the terms "sucker" or "sucking-disk" are misnomers as applied to these organs. A better term might be proposed for these structures in young tadpoles, and Ryder suggests that they be called *epidermal adhesive organs.*

In later stages the structure of the parts about the mouth of the tadpoles of the Salientia furnishes other characteristic peculiarities. But little has been done towards the description of these parts, the North American* and European † species being thus far the only ones studied. These studies have shown that the Hylidæ, Bufonidæ, and Ranidæ have certain characters in the regions mentioned. Below the horny jaws there is a deflexed lower lip, which displays a wide surface anteriorly. This surface is traversed by transverse series of short more or less hook-like bristles. Similar series may or may not extend across above the upper jaw, or on the drooping upper lip at each side of the jaw. The lower lip and part of the upper lip is surrounded by short obtuse papillæ in one or more series.

Now in the Hylidæ, in the regions mentioned, no series of bristles extend across above the upper jaw except a very short one which hangs over the jaw itself; and the upper lip-fold on each side of it bears a row of papillæ. The papillæ form a complete border round the lips, except the interruption at the middle above. In the Bufonidæ there is a row of bristles entirely across the upper jaw, and another below the first, interrupted at the middle region by the horny jaw. The papillæ do not extend on the upper lip-border, and are uninterrupted at the middle of the margin of the lower lip. The papillary border presents an angle inwards at the line of junction of the upper and lower lips. The Ranidæ resemble the Bufonidæ, with one exception in the arrangement of the papillary border. The latter is continuous all around below. The upper jaw is narrower than in the Bufonidæ.

Boulenger describes the larva of the *Rana alticola* of northeast India as possessing three parotoid glands, two on the scapular and one on the coccygeal region, which are not retained in the adult. Also a larva of a tree frog from Java, probably a Rhacophorus, which possesses a ventral suctorial disk in the position of that of a fish of the Gobiësocidæ.

The external gills are suppressed on the right side before they are on the left. In the *Rana clamata* this suppression takes place on the third day after leaving the egg, while the left gill remains until the eighth day. When the internal gills are in functional use the water of respiration issues, in most of the families, from a single rounded orifice on the left side, the subcutaneous branchial chamber of the right side communicating with that of the left side by way of the gular region, beneath the sublingual and geniohyoid muscles and the integument. (See Plate 51, figs. 2–3–7–8.) The fore-legs develop within these subcutaneous spaces behind the internal gills, and remain concealed up to a considerable relative size, and after the hind legs have acquired size enough for some functional efficiency. The left fore-leg then issues through the branchial orifice, and the right leg forces a passage through the integument at a corresponding position on the right side. For a time after

* See Miss M. Hinckley, Proceed. Boston Soc. Nat. Hist., 1882, p. 307.

† Heron Royer et Van Bambeke, Bull. Soc. Zoöl. France, April, 1881.

the fore-legs are thus external the branchial chambers remain in free communication with the external medium by the slit around the base of each fore-leg. These soon close, however, and the skin of the fore-leg is cut off from that of the body adjacent by a distinct seam, which disappears later. This part of the development of the Salientia is one of the most remarkable histories in the zoology of the vertebrata.

The skin which covers the fore limb of the advanced tadpole is not a part of the true skin which invests the body, since the branchial cavity is inclosed long before the leg appears; but it arises beneath the mucous membrane which lines the branchial chambers. This anomaly is perhaps a case of reversion. The fore-legs of primitive Batrachia were no doubt external, as in salamanders, and they became inclosed by the growth of the operculum-like integument in the larval Salientia. A prolongation of the tadpole stage would result in a retardation of the growth of the fore-leg and an acceleration of that of the operculum. The growth of the true skin of the inclosed region would be thus retarded in the leg and atrophied in the wall of the chamber. (Plate 51, figs. 4–6.)

The shoulder girdle appears separated from other parts of the skeleton, between the muscles. The coracoid and procoracoid form a loop, directed downwards and inwards, far removed from that of the opposite side, and present at this time an arciferous type in all forms of the order Salientia. (See fig. 59.)

The characters of the cartilaginous skull of the larvæ of the Salientia are peculiar and very different from those of the adult. The suspensorium of the lower jaw is exceedingly elongated forwards, so that for the purpose of securing a fixed point for the lower jaw (represented now by Meckel's cartilage) it sends upwards a process near its anterior extremity to the external angles of the cartilaginous ethmoid, forming an articulation. It then descends again, and Meckel's cartilage articulates freely with its extremity. There is a curved cartilage attached to the extremity of each Meckel's cartilage (the two forming a half circle, opening forwards), which form the support of the functional lower lip in the larva. These are the lower labial or symphyseal cartilages, and are represented in the adult by a pair of short bones of the same name (mentomeckelians of Parker). The premaxillary bones are in like manner represented by two cartilages, which are loosely attached above to the two corresponding processes or cornua of the trabecular cartilage, which form the roof of the muzzle in front of the ethmoid. (Plate 50, fig. 2.) The ceratohyal is a robust bone, which articulates with the quadrate cartilage below the orbit, contracting in diameter as it extends downwards and forwards. In the process of growth its articulation with the quadrate becomes more and more posterior, until it leaves that element entirely, and comes in contact, and in some cases fuses, with the cartilage of the base of the skull in front of the stapes and near the interstapedial. (Plate 50, fig. 3.)

Besides the structures of the larval hyoid apparatus already de-

scribed (*antea*) there are four cartilaginous arches below the ceratobranchials, which belong to the dermal system, and which are called extrabranchials. Proximally the first of these is articulated with the anterior exterior angle of the hyobranchial plate. Distally the four are united together. These arches support a system of branchial fringes, which are internal in position, and are contradistinguished from the external branchiæ which the Salientia exhibit when first hatched, and which are the only branchiæ of the Urodele and other tailed types. They are thought by Huxley and Parker to be homologous with the branchial structures of the Marsipobranchii or lampreys. (Plate 51, fig. 1.)

The development of the auditory ossicles and cartilages exhibits the following facts. The epistapedial disk appears in its normal position, covering the flexure of the quadrate cartilage. The interstapedial appears as a bud in front of and distinct from the stapes, and the mesostapedial appears as a small membrane on its apex. At a period of its growth the interstapedial cartilage connects the stapes with the quadrate cartilage, as in Trematodera and larval Pseudosaurian Urodela. At the same time the ceratohyal articulates with the quadrate more distally, so that at this stage a Rana presents the characters of a transitional stage seen in the salamandrine genera Spelerpes and Plethodon. The interstapedial then elongates until it reaches the annulus tympanicus. These facts go to show that the interstapedial and mesostapedial are not segmented from the ceratohyal or meckelian arches, and are therefore not homologous with the *ossicula auditus* of mammalia, unless, indeed, the embryonic record has been greatly falsified by cænogeny. (Plates 49, 50.)

ORIGIN AND EVOLUTION OF THE SALIENTIA.

The oldest Salientia of which we have any knowledge were obtained from the Jurassic beds of the Rocky Mountains by Professor Marsh.* They occur in lower Eocene beds in North America (Green River shales)† and in Middle Miocene of Switzerland (Eppelsheim)‡ and Germany (Braunkohle of the Rhine).§ They are not rare in the Upper Miocene of North America (Loup Fork, of Kansas).‖ Forms which by their structure would connect this order directly with the extinct orders are unknown. It is, however, entirely probable that, as already pointed out (p. 14), the Salientia were derived from the Rhachitomi, but whether the Stegocephali enter the line or not is uncertain. The compacted inferior pelvic elements without obturator foramen of the Salientia is much like the same condition in the Rhachitomi, and to produce an almost

* Proceed. British Ac. Sci., 1887, Aberdeen; on the evidence furnished by Dr. Otto Meyer.

† Cope, Rept. U. S. Geol. Surv. Terrs., III, 1885, p. 100.

‡ Tschudi, Classif. d. Batrachier, 1838.

§ Von Meyer, Palæontographica, 1860, p. 123.

‖ Cope, American Naturalist, 1880, p. 141.

identity between the two types it would only be necessary to elongate the ilia of the latter. The developed sternal apparatus and shoulder girdle of the Salientia is only found among Batrachian orders in the Rhachitomi and Stegocephali. Thus in Eryops of the former there are clavicles, coracoids, and episternum (the last reduced as in Urodela), and in Actinodon there is also an epiclavicle (Gaudry). The posterior direction of the suspensorium of the lower jaw of the Salientia is also only found in the extinct orders named, pointing again to this origin. In other recent orders these bones are directed forwards.

The modifications effected in the Rhachitomous skeleton to produce the Salientian, have been partly the same as those which have produced the other existing orders. Thus the true vertebral centra have been replaced by complete intercentra, and several posterior cranial bones have been lost. The ilia have been greatly elongated, and in so doing have embraced vertebræ successively more and more anteriorly, so that the number between the ilia and the cranium has been greatly reduced, and the vertebræ posterior to the point of attachment become atrophied in part and concrescent in part. This process has been carried to the greatest degree in the extinct family of the Palæobatrachidæ. Here the ilia extend to two vertebræ in advance of the ninth or usual sacral, thus inclosing three vertebræ in the sacrum, and leaving only *six* for the remainder of the column. The coracoid is probably that of the Stegocephalous order, as it is better developed than in the Rhachitomi. The second row of the tarsus has also become reduced from these primitive types by atrophy, while the first row has been reduced to two bones, as in the Mammalia, which have been greatly elongated. A parallel case occurs in the Mammalia in some lemurs, particularly in the Tarsiidæ.

I have discovered that the Ganocephala (Trimerorhachis), and the Rhachitomi (Tatrachys) possessed an elongate columella auris, which is directed outwards, backwards, and upwards to a possible *membranum tympani*, which may have occupied the notch external to the *os intercalare*.* (Plate 50, figs. 4–7.)

The subdivision of this rod may have given origin to three of the four distinct elements exhibited by the Salientia. (Plates 49, 50.) The homologies of these with the three principal *ossicula auditus* is possible. The history of these parts shows that the lack of auditory ossicles displayed by some Salientia and by all Urodela (Plates 48, 49) is the result of degeneracy.

The cause of some of the modifications of the skeleton can be traced to use. Thus the constant muscular stress on the ilia in humping the back previous to leaping must have had a tendency to draw it forwards not only on itself, but on its vertebral attachments, which are cartilaginous and yielding. The elongation of the first row of tarsal

*American Naturalist, 1888, p. 465; American Journal of Morphology, Vol. II, Pt. II, 1888.

bones may be traced to a similar cause, especially the stress upon them at the moment of starting a leap and alighting from it. The survival of the elongate coracoid bone may be traced to use by pressure along its longitudinal axis in the act of seizing the female, and possibly by stress in the opposite direction when engaged in pushing objects outwards with the fore-feet, producing the effect of elongation. It is not easy to assign a cause for the loss of the præsternum and of various cranial bones. It has been, perhaps, in these comparatively unused parts that one effect of the general reduction in size and vigor which has occurred during geological time since the Carboniferous and Triassic periods, is to be seen. The loss of auditory organs is probably due to disuse, the result of subterranean life.*

The larval life of the Salientia has probably undergone important modifications during the course of geologic time. The characters assumed by tadpoles at different stages of their growth are not parallels with known or probably to be discovered lower forms of life, but indicate that the larva, like that of the Insecta, and like the mammalian fœtus, has had a developmental history of its own. In support of this view I cite the anterior production of the quadrate cartilage, which carries with it the ceratohyal arch from its primitive attachment, and the ultimate shortening of the same, and the return of the ceratohyal to nearly its primitive connection with the skull. Further, the gradual inclosure of the fore-leg in the external branchial chamber is to be cited, the original position of the limb having been external. To these may be added the development of the epidermal stickers, of the labial dermal comb, and of peculiar dermal glands in some tadpoles. None of these peculiarities of larval life are found in the Urodela, and they have been gradually assumed by the larvæ of the Salientia in the course of their existence, as though they were adult animals, and probably in obedience to the same kind of laws. These are the interaction of the animal and its environment.

CLASSIFICATION.

The natural divisions of the Salientia are the following:

I. No tongue; one pharyngeal opening of the Eustachian tube.
Pterygoid bones inclosing Eustachian tubes below; coracoids and procoracoids divergent, connected by a cartilage which does not overlap that of the opposite side ..... *Aglossa.*

II. Tongue present; two ostia pharyngea.
Clavicle and coracoid of each side connected by a longitudinal arched cartilage, which overlaps that of the opposite side; scapula free from the skull. ..... *Arcifera.*
Clavicles and coracoids of both sides connected by a single narrow median cartilage; scapula articulated with a special condyle of exoccipital. *Gastrechmia.*
Clavicles and coracoids of both sides connected by a single median cartilage; scapula distinct from skull ..... *Firmisternia.*

*See Facts and Opinions relating to the Deaf, by Alex. G. Bell, London, 1888, p. 89.

The presence or absence of maxillary teeth was formerly regarded by the author, after Duméril and Bibron, as of primary value in the definition of the suborders. On account of the absence of teeth, a division Bufoniformia was distinguished from the Arcifera; and the tooth-bearing Fermisternia were called Raniformia. I, however, now follow Boulenger in dropping these divisions, since the absence of teeth is sometimes of little systematic significance.

In the arciferous type of scapular arch the opposite halves are capable of movements which contract or expand the capacity of the thorax; in the Firmisternia the opposite halves abut against each other so as to be incapable of movement, thus preserving the size of the thoracic cavity. This arrangement has an important bearing on the comfort, and perhaps health, of the female while in connection with the male. The embrace of the fore-legs of the latter behind the axillæ of the former is very energetic, and is maintained by various structural aids. Thus in many species the males develop rough and even spinous horny plates on the inner superior side of the thumb, which presses against the thorax of the female.

The firmisternial structure is a modification of the arciferous, which comes later in the history of growth, and probably in geological time. During the early stages the Firmisternia have the movable shoulder girdle which characterizes those of the arciferous division, the consolidation constituting a modification superadded in attaining maturity. Furthermore, young Salientia are toothless, and one section of the species of Arcifera never acquire teeth. In these (the Bufonidæ) we have a group which is imperfect in two points instead of one.

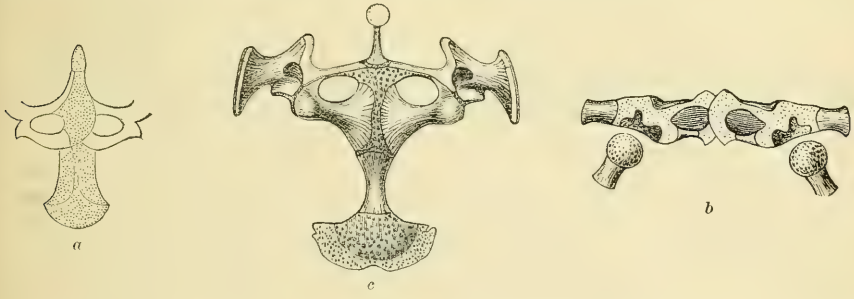
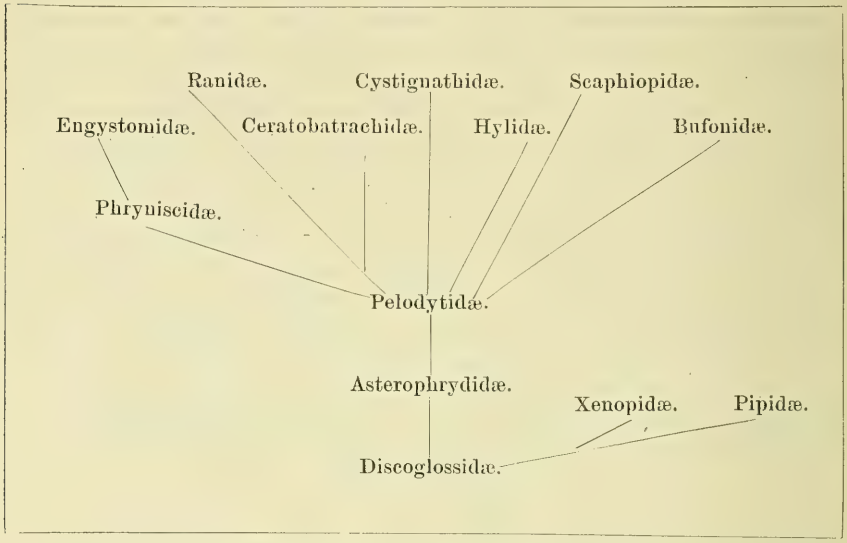


FIG. 59.

Shoulder girdles of Anura. Fig. *a* of the arciferous type (*Scaphiopus holbrooki*). Fig. *b*, *Rana temporaria*, tadpole with budding limbs. Fig. *c*, do., adult, firmisternial type. Figs. *b* and *c* from Parker.

As primitive Batrachia are toothed, it is evident that the toothless condition of the Bufonidæ and some other families is due to retardation or degeneracy. The arciferous sternum is, on the other hand, a primitive condition, since it prevails in the Urodela, and also in the Stegocephali and Rachitomi of the Carboniferous Age, in the latter associated with median sternal elements. The roofing in of the Eustachian tubes seen in the Aglossa is also a character superadded to the primitive condition, as the loss of tongue is a case of subtraction.

The Discoglossidæ must be regarded as the most primitive family of the Anura, as it shows none of these peculiar modifications, and presents the greatest resemblance to the salamanders in its ribs and opisthocœl vertebræ, and to other primitive types in its split sternum. In the accompanying diagram these affinities are expressed, and a possible phylogeny is indicated. That the latter will prove largely correct is shown by the presence of Discoglossidæ in the Miocene beds of Prussia, particularly near Bonn. The paleontology of the Salientia is, however, very imperfectly known.



The Arcifera and Firmisternia each exhibit parallel modifications of structure, which may be represented as follows in tabular form:

Arcifera.	Firmisternia.
I. Without teeth.	
α. With sacral diapophyses dilated.	
Bufonidæ	Brevicipitidæ. Engystomidæ. Phryniscidæ.
αα. Sacral diapophyses cylindric.	
Dendrophryniscidæ	Dendrobatidæ.
II. With premaxillary and maxillary teeth only.	
α. With sacral diapophyses dilated.	
Pelodytidæ, Pelobatidæ, Hylidæ	Dyscophidæ. Cophylidæ.
αα. With sacral diapophyses cylindric.	
Cystignathidæ	Colostethidæ. Ranidæ.
III. Teeth in both jaws.	
α. Sacral diapophyses not dilated.	
Amphignathodontidæ, Hemiphractidæ	Ceratobatrachidæ.

The families of Arcifera with opisthocœlous vertebræ are omitted from the table as having no counterpart among the Firmisternia.

These two series are what I have called "homologous groups," and the corresponding genera "heterologous terms. I have also supposed that one such series may have been derived from the other, in evolution, by a change in the one character which distinguishes the two series. In the case of some homologous series it is not unlikely that this may have taken place, but it is necessary, in order to be sure that such has been the process of evolution, to distinguish between two different kinds of homologous groups. In one kind the parallel characters of the one group may have been derived from those of the other by descent, according to the principle called by Lankester "homogeny." In the other case, like modifications of structure have arisen in different series of animals as a result of the operation of similar energies, as that of the animal and its environment. This is the principle of "homoplassy." To the latter kind belong the imitations found to exist between the placental and didelphian mammalia. The relation between the arciferous and firmisternial Anura may be one of homogeny. We may then parallelize the families which may exhibit true cases of descent as follows:

Firmisternia.	Arcifera.
Phryniscidæ.	Bufonidæ.
Dendrobatidæ.	Dendrophryniscidæ.
Dyscophidæ.	Pelodytidæ.
Ranidæ.	Cystignathidæ.
Ceratobatrachidæ.	Hemiphractidæ.

It is, however, probable that the Pelodytidæ is the generalized form from which most of the arciferous families have been derived; and it was itself probably a descendant of the families with opisthocœlous vertebræ, as already indicated.

The Ranidæ embraces many genera which imitate in details many genera of Arcifera. The metropolis of the former, as of the *Lacertilia acrodonta*, is the *regio Palæotropica*, while the latter have but few representatives out of the *R. R. Neotropica* and *Australis*, where but one or two species of the former occur. In both we can trace a series in which the outer metatarsal is gradually liberated from the penultimate, to afford greater extension for the web in the most aquatic types, and among those where these bones are bound, from webless to webbed types. In both we have burrowing and arboreal genera.

In strict reference to the extension of the webs the following parallels may be drawn:

	Ranidæ.	Arciferi.
External metatarsal free:		
Aquatic.	Rana.	Pseudis.
Subfossorial.	Hoplobatrachus.	Myxophyes.
External metatarsal attached:		
Feet webbed—		
Burrowing.	Pyxicephalus.	Ceratophrys.
Arboreal (vom. teeth).	Leptopelis.	Hyla.
Arboreal (no vom. teeth).	Hyperolius.	Hylella.
Aquatic.	Heteroglossa.	Acris.
Feet not webbed—		
Terrestrial.	Cassina.	Cystignathus.
Terrestrial, spurred.	Hemimantis.	Paludicola.

It is, however, remarkable that the raniform tree-frogs nearly always have the external metatarsal bone free; the arciferous always bound. The terminal phalanges of the latter are constructed on a ball-and-claw type. In the former they are T-shaped or bifurcate, except in the single West African genus Leptopelis, where the South American type is repeated.

I have also discovered another series of parallels which the genera of most of the families of the Salientia present, in the degree of ossification of the superior cranial walls.* In the least-ossified crania we find the superior part of the ethmoid still cartilaginous, the superior wall of the brain-case membranous, and the prefrontals represented by narrow lateral splints of bone. In genera of slightly advanced type the roof of the ethmoid is ossified, and the prefrontals are wider. In better-developed genera the frontoparietal bones ossify and close the fontanelle. The higher ossification shows itself in an exostosis of the superior cranial walls, which, in further stages, involves the skin, so that it is no longer free from the cranium. The next stage roofs over the temporal muscle with bone, and the highest stage, known only in a genus of Bufonidæ (Otaspis Cope), incloses the membranum tympani behind. The following table expresses these facts.

These series give an excellent illustration of the development of a single character independently of other characters, and show how the generic characters originate quite independently of all others.

*See Nat. Hist. Rev., 1865; Proceed. Ac. Phila., 1868 (on the Origin of Genera); Origin of the Fittest, 1887, p. 218, Plates IV and V.

Classification.	Bufonidæ.	Scaphiopidæ.	Cystignathidæ.	Hylidæ.	Ranidæ.
A. Ethmoid not ossified	Myobatrachus.		Eusophus	Thoropa	Ranula.
AA. Ethmoid ossified above:					
1. A frontoparietal fontanelle—					
a. Prefrontals narrow		Didocus	Borborocœtes.	Hypsiboas	
aa. Prefrontals wide	Epidalea	Spea	Cyclorhamphus. Hyperolia	Hyla (sp.)	
11. No fontanelle; skin free; no exostosis—					
a. Prefrontals narrow			Elosia, etc		Rana (oxyrhyncha).
aa. Prefrontals wide	Bufo sp		Hylodes, etc.	Scytopis	Rana (hexadactyla).
111. No fontanelle; skin free; exostosis—					
a. Prefrontals narrow				Osteocephalus.	
aa. Prefrontals wide	Bufo sp				
1111. No fontanelle; integument involved in exostosis.	Peltaphryne Cranophryne.	Scaphiopus Pelobates	Phractops	Trachycephalus.	Polypedates.
11111. Skull exostosed, involving integument; temporal fossa roofed		Cultripes	Calyptocephalus.		
111111. As last, but membranum tympani inclosed behind	Otaspis				

Figures of these and intermediate types of crania will be found in Plates 68 to 75.

The adaptive result attained by these changes in the cranial ossification are two. Both in burrowing in the earth and in presenting a defense against enemies, the top of the head is presented to the resisting object. On being atacked, a Salientian Batrachian always depresses the muzzle and presents the top of the head to the enemy. The types with well ossified crania have a great advantage over those in which the front is membranous or cartilaginous, especially in the case of attack from venomous snakes, stinging insects, etc. There is, however, no definite distribution for the respective types, either in time or space, except that the genera with unossified ethmoid all belong to the Southern Hemisphere. Also, types with unossified frontoparietal bones predominate in the Australian and Neotropical realms, are unknown in the Ethiopian, and rare in the Paleotropical. Types with exostosed frontoparietals chiefly abound in the Neotropical realm, and occur in the Nearctic and Palæarctic. Paleontologically, both exostosed (Latonia) and membranous frontoparietals (Alytes) appear together in the Miocene brown-coal of Bonn, in Rhine-Prussia.

As regards the distribution of Salientia in North America, the following general remarks may be made. The eastern district, with its comparatively humid climate and abundant-water courses, is the home of the genus Rana. For similar climatic reasons the middle and northern parts of the Pacific region have several species of Rana. The eastern region, the land of forests, possesses nearly all the species of Hyla. The Pacific coast has but one, a fact due, perhaps, to its long dry season

The arid regions of the Southwest furnish the greater variety of species of Bufo, but one species inhabiting the eastern region. The Austroriparian region is the home of several small forms of Hylidæ and Bufonidæ. The distribution of the Scaphiopidæ is chiefly in the dryer regions of the West; three species are found in the Sonoran, while but one occurs in the Pacific, and one in the eastern and Austroriparian regions. The distribution may be tabulated as follows:

Genera.	Austro-riparian R.	Eastern.	Central.	Sonoran.	Pacific.
Bufo	4	1	2	5	1
Scaphiopus	1	1	1	3	1
Chorophilus	5	1	1	.....	.....
Hyla	6	4	.....	1	1
Acris	1	1	1	.....	.....
Hylodes	2	.....	.....	.....	.....
Syrrhophus	1	.....	.....	.....	.....
Rana	4	8	1	2	4
Totals	24	16	6	11	7

AGLOSSA.

The few members of this suborder have the vertebræ opisthocœlous and deprived of ribs; the diapophyses of the third and fourth vertebræ are extremely elongate, and those of the sacral are strongly dilated and confluent with the urostyle. The third ceratobranchials are greatly elongated.

In *Pipa* there are only seven presacral vertebræ.

The frontoparietals are entirely ossified, and there are true ossa nasalia.

The sternal apparatus belongs to the arciferous type, though the epicoracoid cartilages do not overlap.

The larvæ are provided with two spiracula, one on each side of the body. (Boulenger).

There are two recent and one extinct families of this suborder, which are defined as follows:

PIPIDÆ.

No ribs; vertebræ opisthocœlous; urostyle simple, attached to a single condyle. Coracoid and epicoracoid divergent, their connecting arches not overlapping. No manubrium. Teeth none; sacral diapophyses dilated.

The neotropical genus Pipa has the atlas confluent with the second vertebra, so that there are but seven anterior to the sacrum. There are distinct nasal bones, and the median septum of the ethmoid is partially ossified. The prefrontals are completely in contact with each other and with the frontoparietal. Frontoparietal completely ossified. Terminal phalanges acute, simple. External metatarsals separated by a web. (Plate 69, figs. 1–2.)

XENOPIDÆ.

No ribs; vertebræ opisthocœlous; os ilium attached to the ninth vertebra only. Coracoids and epicoracoids well separated from those of the opposite side. Teeth present; sacral diapophyses dilated.

One genus, Xenopus, with three species in the regio Æthiopica. In this the interorbital ethmoid plate, though long, is not produced anteriorly, and is entirely concealed by the frontoparietal. Frontoparietal strongly ossified, overhanging the confluent prefrontals. The prefrontal does not always extend to it. The first two vertebræ are separate, but the sacral and coccyx confluent. There are ossa nasalia above the nares. Terminal phalanges acute, simple. External metatarsals separated by a web. (Plates 49, fig. 10 and 69, fig. 2.)

PALÆOBATRACHIDÆ.

No ribs; os ilium attached to the diapophyses of the confluent ninth, eighth, and seventh vertebræ, which form a disk; urostyle attached by a double glenoid cavity. Frontoparietal strongly ossified, not produced farther than the separate prefrontals. External metatarsals probably separated by a web.

The genus *Palæobatrachus*, Tsch., represented by several species in the Miocene of Germany. The superior plate of the ethmoid was concealed, and the atlas confluent with the first vertebra, leaving but six between the occiput and sacrum.*

Von Meyer describes the vertebræ of *P. giganteus* as procœlous, while some of them are figured as opisthocœlous. Woltersdorff† states that they are procœlous. A specimen in the British Museum which I examined has opisthocœlous vertebræ. It remains, therefore, a question of interest whether this family belongs in the Aglossa. Woltersdorff, who has studied it very carefully, refers it to the Arcifera, and to the neighborhood of the Pelodytidæ, although admitting various points of resemblance to Xenopus. He describes nine species from various parts of central Europe.

ARCIFERA.

In this tribe the extremes of the series are more diverse than in the others, and depend on the following features:

(1) In that nearest the Aglossa the vertebræ are, like those of the latter and of the Salamanders, concave posteriorly and convex anteriorly; in the other extreme the reverse. These features are not as irreconcilable as might at first sight appear, as the intervertebral spheres do not become firmly attached to either centrum at maturity in some individuals of *Borborocœtes peronii*, *Pelobates fuscus* (Stannius), and *Cultripes provincialis* (Dugès). (2) Those with opisthocœlous vertebræ

*Palæontographica, III, p. 147.

†Ueber fossile Frösche insbes. das g. Palæobatrachus, Magdeburg, 1886.

agree with the bulk of the tribe in possessing dilated sacral diapophyses, whilst those at the other extreme exhibit them cylindrical. (3) A few of the former possess small ribs, and (4) the urostyle approaches the normal condition of vertebræ in possessing one pair of transverse processes; (5) most of these, with the adjoining less extreme forms, have a vertical or cat-like pupil. (6) Many of the same group exhibit a degraded or obliterated auditory apparatus; but this feature is not uniformly coincident with the preceding ones. (7) The xiphisternum is formed of divergent limbs; in the bulk of the tribe it is an emarginate cartilaginous plate, and in the opposite extreme an osseous style, as in the Ranidæ.

Of these features the first, third, fourth, and sixth are agreements with or approximations to the structures of the same elements of the Salamanders; the resemblances are borne out in the physiology of the same types.

In the observed examples of the above types that is, of the Discoglossidæ, Pelodytidæ, and Scaphiopodidæ, the eggs are deposited in small clusters (Pelodytes), a short thick loop (Pelobates), or in a series with a slender, tough, thread-like attachment (Alytes). In the family following that of the Pelobates, that is the New World tree-toads, the eggs are, in the Old World species (*Hyla arborea*) deposited in globular masses, as among the Ranidæ, but much smaller, while in our *Hyla pickeringii* the masses include but from four to ten eggs. In the first-mentioned forms the male seizes the female in front of the thighs, while in the remaining and major number of species, as well as in the observed Firmisternia, she is seized around the axillæ.

Additional peculiarities in the development of Alytes, Pelodytes, Cultripes, and Pelobates are, that they spawn at two seasons instead of one, and that their larvæ attain a larger size than those of other Anura before completing their metamorphosis. This latter feature is, however, repeated near the other end of the series—among those with cylindrical pelvic supports, in the genus Pseudis.

The occurrence of a xiphisternal style similar to that of the Ranidæ may be regarded as an indication of superiority not only in consideration of this affinity, but as a greater degree of specialization and ossification of the part. It appears, however, not merely among the most raniform Arcifera, and among some with procœlous vertebræ, which have the salamander-like mode of reproduction, but also among some of the opisthocœlous species.

The only family features as above given which seem to have a functional significance, are the structure of the terminal phalanges as an adaptation to arboreal life in the Hylidæ and the increase of raptorial power by the addition of another set of teeth in the Hemiphractidæ. Yet for the first-mentioned function other arrangements are employed in other families.

The families of this suborder differ as follows:

I. Ribs present (Discoglossoidea Gill).
Vertebræ opisthocœl; sacral diapophyses dilated; sternum bifurcate. ..... *Discoglossidæ.*

II. Ribs absent (sternum not deeply bifurcate). (Bufonoidea Gill).
A. No teeth (vertebræ procœl).
Diapophyses of sacrum dilated ..... *Bufonidæ.*
Diapophyses of sacrum not dilated ..... *Dendrophryniscidæ.*
AA. Maxillary teeth only.
Vertebræ opisthocœl; sacral diapophyses dilated; urostyle distinct. ..... *Asterophrydidæ.*
Vertebræ procœl; sacral diapophyses dilated; urostyle distinct; ungual phalanges conic ..... *Pelodytidæ.*
Vertebræ procœl; sacral diapophyses dilated; urostyle confluent with sacrum; ungual phalanges conic ..... *Scaphiopidæ.*
Vertebræ procœl; sacral diapophyses dilated; urostyle distinct; ungual phalanges a curved claw with globular base ..... *Hylidæ.*
Vertebræ procœl; sacral diapophyses not dilated; urostyle free; ungual phalanges conic, sometimes transverse at apex ..... *Cystignathidæ.*
AAA. Maxillary and mandibular teeth present.
Sacral diapophyses dilated ..... *Amphignathodontidæ.*
Sacral diapophyses not dilated ..... *Hemiphractidæ.*

Of the above families, four are found within the boundaries of the Nearctic Realm. These are the Bufonidæ, Scaphiopidæ, Hylidæ, and in a very few representatives, the Cystignathidæ. Three of the families are confined to the Neotropical Realm—the Dendrophryniscidæ, the Amphignathodontidæ, and the Hemiphractidæ. The Hylidæ belong to this fauna and the Australian, with a large representation in the Neartic and a very small one in the Palæarctic Realms. It is totally wanting from the Ethiopian. The Discoglossidæ is European, with one genus in New Zealand. It is the only family well represented by tertiary forms. The small family of the Asterophrydidæ are Palæotropical and Australian, and the few Pelodytidæ, Palæotropical and Palæarctic. The large family of the Cystignathidæ are Neotropical and Australian only. The Bufonidæ are cosmopolitan, and the Scaphiopidæ Nearctic and Palæarctic. But the greater number of the Arcifera are Neotropical.

We are at present acquainted with 501 species of this suborder, which represent 84 generic types. They represent the families in the following proportions and regions:

	Genera.	Species.	Distribution.
Discoglossidæ	5	8	R. Palæarctica (Australis).
Asterophrydidæ	4	6	R. Palæotropica, Australis.
Pelodytidæ	3	4	R. Palæotropica, Palæarctica.
Scaphiopidæ	4	7	R. Palæarctica, Nearctica.
Hylidæ	16	189	(R. Palæotropica) R. Palæarctica, Nearctica, Neotropica, Australis.
Amphignathodontidæ	1	1	R. Neotropica.
Hemiphractidæ	3	8	R. Neotropica.
Cystignathidæ	35	174	R. Neotropica, Australis.
Bufonidæ	14	102	Cosmopolite.

The generic forms are all peculiar to their zoological regions, except Hyla, found wherever its family occurs, and Borborocœtes, common to Australia and the southern portion of South America.

The number of species so far known to inhabit these regions is as follows:

Regio Australis	55		446
R. Neotropica	363	R. Palæartica	12
R. Nearctica	28	R. Æthiopica	9
		R. Palæotropica	50
Total	446		
		Total	517
In two regions	1	In two regions	2

The small proportion of species occurring in the Old World, exclusive of Australia, is evident, though they represent six families, while those of the New World represent but six also.

The tribe Arcifera was first defined and its extent and distribution indicated by the author in the Natural History Review, 1865, though explained a year previously at a meeting of the Zoological Society of London. The sternal feature characterizing it was noticed by Steetzen, Cuvier, and others in isolated cases, but its general significance not perceived. Dugès (Recherches, 64) attributes it to the tree-toads, the toads, and the Bombinator, Alytes, and Pelobates. In Stannius's Zootomie der Amphibien (73) it is assigned to the Aglossa and Bufo, as distinguished from Rana and Cystignathus. The characters of the last genus must have been taken from the Old World Cassina (formerly called Cystignathus), as the structure in Cystignathus and its allies is that of the true Arcifera.

DISCOGLOSSIDÆ.*

Cope, Nat. Hist. Rev., 1865 (Jan.); Journ. Phila. Ac., 1866, p. 74; Lataste, Actes de la Soc. Linn. de Bordeaux, 1879, p. 277; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, 444.

Vertebræ opisthocœl.† Diapophyses of sacrum dilated. Urostyle with a basal diapophysis. Ribs present.‡ Bones of distal carpal series all distinct. Sternum of two slender postero-exteriorly diverging fibrocartilaginous or cartilaginous styles.

In the known genera tongue is round, entire, and little or not at all free behind. Males without vocal vesicle.

A marked peculiarity characterizes the larvæ of this family. The spiracle or branchial opening is situated on the median line below, while in all other tongued Anura it is situated on the left side.

If we commence the series of the Arcifera with the great family of the Cystignathidæ, we will end it with the families Asterophrydidæ and Discoglossidæ, which are perhaps equally connected with that which precedes them—the Scaphiopodidæ. The former leads to Xenopus through Palæobatrachus; the latter, as far as our present knowl-

* Plate 78.

† Observed by Dugès and Gervais in Alytes.

‡ Observed by Dugès in Alytes and Bombinator, and by Duméril in Discoglossus.

edge indicates, finds its completest development in the extinct genus Latonia, established by Von Meyer on the *L. seyfriedi* from the Miocene of Oeningen. A species also occurs in the fresh-water deposits of Sansan (*L. rugosa*), whose salamander-like vertebræ have been noticed by Gervais.* These animals were nearly related to Discoglossus, and had, like it, short posteriorly directed processes on the ribs, as in the genus Salamandra. They were, however, much larger, had the fronto-parietal bones completely ossified, and the whole of the cranium roughened externally by a dermo-ossification. On this account the genus has been compared with Ceratophrys, which belongs to the family of Cystignathidæ.

In the remaining and recent genera the structure of the sternum is worthy of note. In old individuals of Discoglossus it is sometimes fibro-cartilaginous, as in Pipa. The sternum, homologous with the sternum of the Lacertilia, resembles the united hæmapophysial cartilages of the anterior ribs. In the genera in question † this part is divided nearly up to the point of attachment to that preceding, each moiety being directed outwards and backwards, and tapering into a lateral linea semilunaris. Between these and the pubes there are in Discoglossus the usual three pairs of lineæ semilunares, connected on the median line by a strong linea alba.

In Discoglossus the prefrontalia are strongly developed, being in contact for most of their length, sometimes touching the fronto-parietalia. In Alytes they are also in contact throughout, but are transverse and do not reach the fronto-parietals; the fontanelle is larger, and the ribs without processes; the whole animal is weaker. In this genus, as well as the preceding, the pupil is a vertical slit; elsewhere found in Hylorhina, Platyplectrum, Limnomedusa, Pelodytidæ and the Scaphiopidæ. A species (*A. troschelii*)‡ has left its remains in the Miocene Braunkohle along with Palæobatrachus. Bombinator is similar to Alytes in its osseous structure, except that the prefrontalia are in contact anteriorly only, and that the sacrum presents but one condyle for the articulation of the coccyx, as is typical of the Asterophrydidæ and Aglossa. Along with Alytes and Xenopus it has true ossa nasalia, which bound the external nares exteriorly, thus explaining their anomalous position in Breviceps, where they are inferior. In Bombinator there is no cavum tympani or auricular ossicles, and the tubæ Eustachii are rudimentary or wanting. This character is said by Tschudi and Bruch not to be exceptionless in adults, and that the tubæ and tympanum are always present in the young of both this genus and Pelobates. All European, except Lio-

* Palæontologie Française, p. 494.

† Dugès has given a figure of it in *Bombinator*, Pl. 3, fig. 24.

‡ Cope, Journ. Acad. Phila., 1866, p. 75. *Rana troschelii* (Von Meyer, Palæontographica, III, p. 138).

pelma, which is from New Zealand. The toes are webbed in all the genera, and the external metatarsals are separated.

Cephalic integument involved in cranial ossification, which completes the o. o. frontoparietalia; two coccygeal cotyli and diapophyses; ribs with posterior process ..... *Latonia* Von Meyer.

Cephalic integument free; a small frontoparietal fontanelle (sometimes *apparently* closed by the ethmoid); prefrontralia largely in contact; two coccygeal cotyli; ribs with posterior process; pupil round; cavum tympani present. No parotoid glands ..... *Discoglossus* Otth.

Cephalic integument free; a frontoparietal fontanelle; vomerine teeth present; two coccygeal cotyli; pupil triangular; no tympanum or Eustachian tubes (Boulenger) ..... *Liopelma* Steindachner.

Cephalic integument free; a frontoparietal fontanelle. Prefontalia in contact throughout; two coccygeal cotyli; no rudimental digit; typanum and cavum tympani distinct; pupil erect; parotoid glands present ..... *Alytes* Wagl.

Cephalic integument free from cranium; a frontoparietal fontanelle; prefontalia in contact anteriorly; one coccygeal cotylus; no inner digit developed; no tympanum or cavum tympani; Eustachian tube rudimental or wanting; parotoid glands none ..... *Bombinator* Merrem.

All the characters of this family go to show that it is the nearest of the Salientia to the original and now extinct type which formerly connected that order with the Salamanders. These are, the presence of ribs, the opisthocœl vertebræ, the distinctness of the carpal bones of the distal row; the inguinal grasp of the male in copula, and the frequent presence of the cardinal veins.

BUFONIDÆ.*

This is the only cosmopolitan family of Anura. It is chiefly represented by the genus Bufo, which exists in all the zoological realms excepting the Australian. The variations in structure are not so great as in some other families. They are thus summarily reviewed by Boulenger:

"The omosternum is generally absent; if present, it is reduced to a narrow cartilage. The sternum is usually a cartilaginous plate, which in a few cases is ossified along its center; in Engystomops there is a well-defined bony style supporting a cartilaginous disk.

"The vertebræ are procœlous and without ribs. The diapophyses of the sacral vertebræ are more or less dilated, but never to such a degree as in the Pelobatidæ. The urostyle is attached to two condyles.

"A frontoparietal fontanalle is present in Myobatrachus Engystomops Pseudophryne and Epidalea; † and in a few species of Bufo the derm is completely involved in the cranial ossification.

"In two genera the pupil is erect.

"The distal phalanges are simply obtuse or T-shaped.

"The Bufonidæ include terrestrial, burrowing, thoroughly aquatic (Nectes) and apparently arboreal (Nectophryne) types. Rhinophrynus is a true ant-eater, as are several forms of Engystomidæ."‡

* Plate 78.

† This genus is not admitted by Boulenger.

‡ Catalogue Batr. Sal. Brit. Mus., II, ed. 1882, p. 274.

Other characters are: superior plate of the ethmoid completely ossified; very rarely prolonged anteriorly; usually covered by the completely ossified frontoparietals, or by these and the prefontals together. No pterygoideum. Tongue free, not retractile posteriorly.

In Otilophus and Phrynoidis* there are but eight vertebræ, the atlas and second being confluent. In Nectes there are resemblances to the Asterophrydidæ. The prefontals are narrow, divergent, in contact only anteriorly; the superior plate of the ethmoid is small, tranverse, not entirely covered by the frontoparietals, which are but weakly ossified medially, although embracing no fontanelle. In the other genera the prefontals are in contact with each other and with the fronto-parietals throughout.

In none of the genera *known* to belong to the family is there a manubrium sterni. The xiphisternum is a slender weak cartilage in Pseudophryne and Phryniscus and *Bufo kelaartii*. In the other species the style supporting the terminal disk is stronger, sometimes fibro-cartilaginous; in *Bufo vulgaris* and *B. melanostictus* it is broader and nearly bony, and in *Nectes subasper* strongest and broadest.

In *Bufo kelaartii* the terminal phalanges have a slight terminal transverse extension.

Myobatrachus, Notaden, and Pseudophryne the weakest and least developed forms, are Australian; Eupemphix, Phrynoidis, Bufo, Peltaphryne, Otaspis, Ollotis, Crepidophryne, Cranophryne and Rhinophryne are Neotropical; Bufo and Nectophryne, Ethiopian; Bufo, Nearctic; Bufo and Epidalea, Palæarctic; and Scutiger, Bufo, Nectes, and Nectophryne, Palæotropical.

The characters are the following:

I. Terminal phalanges simple.
  A. Two condyles for the urostyle.
  B. Tongue bound in front, free behind.
    *A frontoparietal fontanelle.
      Ethmoid bone incomplete above; sternum ossified on the middle line; ear perfectly developed; pupil erect. *Myobatrachus* Schl.
      Ethmoid bone complete; fingers and toes free; sternum a weak cartilage ..... *Pseudophryne* Fitz.
      Ethmoid bone complete; toes webbed, sternum distinct. *Epidalea* Cope.
    **No frontoparietal fontanelle.
      α. No vomerine teeth.
        β. Tympanic chamber present.
          Toes free; tympanic drum not inclosed; sternum an osseous style ..... *Eupemphix* Steind.

*The raised orbital ridges of this genus do not constitute its essential character, as formerly supposed, but rather the division of the neural spines and the wide separation of the lateral portions (they stand above the zygapophyses) throughout the vertebral column. Perhaps the fusion of the atlas with the second vertebra is important in the same connection. There is but one species at present known, *P. asper*.

Toes webbed; tympanic drum not inclosed by bone; sternum a plate ..... *Bufo* Laur.

Toes webbed; tympanic drum inclosed with ossification. *Otaspis* Cope.

Toes webbed; nostrils directed upwards..... *Nectes* Bleeker.

ββ. Tympanic chamber wanting.

Cranial derm free; digits webbed ..... *Ollotis* Cope.

Cranial derm free; digits not distinct, inclosed in a common integument ..... *Crepidophryne* *Cope.

Cranial derm ossified; toes webbed ..... *Cranophryne* †Cope.

αα. Vomerine teeth present.

Sternum rudimentary; toes webbed..... *Notaden* ‡Gunth.

BB. Tongue bound or retractile posteriorly; slightly free anteriorly.

Sternum rudimentary; pupil erect .. *Rhinophrynus* Dum. & Bibr.

AA. One condyle for the urostyle.

Pupil vertical; no vomerine teeth; toes free; a sternal style. *Scutiger* Theob.

II. Terminal phalanges T-shaped.

Fingers and toes more or less webbed; the tips dilated into disks; sternum cartilaginous..... *Nectophryne* Buch. & Peters.

The distribution of these genera is as follows :

	Australian.	Neotropical.	Nearctic.	Ethiopian.	Palæactic.	Palæotropical.
Myobatrachus	1					
Pseudophryne	4					
Eupemphix		4				
Epidalea					1	
Bufo		33	10	9	4	25
Otaspis		1				
Nectes						1
Ollotis		1				
Crepidophryne		1				
Cranophryne		1				
Rhinophrynus		1				
Notaden	1					
Scutiger						1
Nectophryne				1		3
Total	6	41	10	10	5	30

BUFO Laurenti.

Syn. Rept., p. 25; Wagl., Syst. Amph., p. 206; Tschudi, Batr., p. 88; Dum. & Bibr., VIII, p. 662; Günth., Cat., p. 55; Nat. Hist. Rev., 1865, p. 102.

Oxyrhynchus Spix, Spec. Nov. Test. Ran., p. 49; Espada, Viaj. Pacif., Vert., p. 170.
Otilophus Cuv., R. A.; Tschudi, Batr., p. 89; Günth., Cat., p. 69; Cope, *l. c.*
Hylaplesia sp. Boie, Isis, 1827, p. 294.
Chaunus sp. Wagl., Isis., 1828, p. 744.
Phryne (Oken) Fitz. Syst. Reptil., I, p. 32.
Chilophryne Fitz. *l. c.*; Cope, Proc. Ac. Phila., 1862, p. 357.
Phrynoidis Fitz. *l. c.*; Cope, *l. c.*, and Nat. Hist. Rev., 1865, p. 102, pars.
Anaxyrus Tschudi, Faun. Per., Herp., p. 78.
Schismaderma Smith, Ill. S. Afr., Rept., App., p. 23; Günth., *l. c.*, p. 138; Cope, *l. c.*

**Crepidius* Cope preoccupied. †*Cranopsis* Cope preoccupied.
‡This genus may have a cranial fontanelle. The skull has not been examined.

Adenomus Cope, Proc. Ac. Phila., 1860, p. 371.
Rhæbo Cope, *cod. loc.*, 1862, p. 357, and Nat. Hist. Rev., 1865, p. 102.
Ansonia Stoliczka, Proc. As. Soc., 1870, p. 152.
Dromoplectrus Camerano, Atti. Acc. Tor., XIV, 1879, p. 882.

Vupil horizontal. Tongue elliptic or pyriform, entire and free behind. Vomerine teeth none. Tympanum distinct or hidden. Fingers free; toes more or less webbed, the tips simple or dilated into small disks. Outer metatarsals united. Omosternum generally missing; if present, cartilaginous; sternum, a cartilaginous plate, sometimes more or less ossified along the median line. Diapophyses of sacral vertebra more or less dilated. Terminal phalanges obtuse or triangular.

In the Proceedings of the Philadelphia Academy for 1854 Dr. Charles Girard gave a synopsis of the North American species of this genus, which embraces thirteen specific names. Eight of these are recognized in the present work, and two others as subspecies. In 1886 the writer gave a synopsis of the species in the Proceedings of the American Philosophical Society, the result of the study of which has been incorporated into the present volume.

I. Head without bony crests above.
  α. Interorbital space wider than eyelid.
    Parotoid glands small, as wide as long, not wider than head; legs longer, end of tarsus reaching to from front of orbit to end of muzzle; metatarsal tubercles insignificant ..... *B. punctatus.*
    Parotoid glands large, long, spreading posteriorly, much wider than head; legs short, end of tarsus to tympanum; metatarsal tubercles insignificant ..... *B. debilis.*
  αα. Interorbital space narrower than eyelid.
    Parotoid gland oval; metatarsal tubercles insignificant; a large gland on tibia; size larger ..... *B. columbiensis.*
    Parotoid gland oval; both metatarsal tubercles with cutting edges, the internal very large; muzzle very short; no large gland on tibia; size smaller ..... *B. compactilis.*
II. Head with bony crests above.
  1. Interorbital space wider than eyelid.
    A strong postfrontal crest; superciliaries divergent backwards; parotoid gland narrow and elongate, descending towards axilla; large glands on thigh and on tibia; head four times in the length; metatarsal tubercles small ..... *B. alvarius.*
  2. Interorbital space narrower than eyelid.
  α. No postorbital ridges.
    Superciliary crests parallel; tympanum distinct; two cutting metatarsal tubercles; femur largely free ..... *B. hemiophrys.*
  αα. Postorbital ridges present.
    Two large cutting metatarsal processes; superciliary crests very divergent and distinct posteriorly, confounded in a nasal boss anteriorly; spots very large ..... *B. cognatus.*
    One smaller metatarsal crest; superciliary crests not incurved and transverse posteriorly; parotoid glands narrow, not descending behind tympanum; large ..... *B. lentiginosus.*
    One smaller metatarsal tubercle; superciliary crests incurved posteriorly so as to be transverse; a supratympanic crest; parotoid gland descending on sides to inferior part of tympanum ..... *B. quercicus.*

Of the species above defined, the *B. columbiensis* and the *B. lentiginosus* are the only ones which display any great variability, the latter having four well-defined subspecies. They are also naturally the species which present affinities to other species. Thus the *B. lentiginosus* sometimes approximates, without becoming confused with, the *B. cognatus*, and the latter in turn varies towards the *B. compactilis*.

BUFO PUNCTATUS B. & G.

Proceed. Ac. Phila., 1852, p. 173; Baird, U. S. Mex. Bound. Surv., vol. II, Rept. p. 25, Plate xxxix; figs. 5–7 (not good), 1859.

Bufo beldingii Yarrow, Proceed. U. S. Nat. Mus., 1882, p. 441.

The head is wide and flat, and enters the total length three and a third times. The width at the posterior borders of the tympana exceeds the length by the diameter of the eyelid. The latter is about four-fifths the very flat interorbital region. The only cranial ridge is the vertical one which extends from between the eyelid and the parotoid gland along the front of the tympanic membrane. The latter is very distinct and is nearly round, and is just half the long diameter of the eye. The prefrontal bones are rather prominent at the canthus rostralis, and are roughened with raised points. The end of the muzzle is strongly convex in profile, its extremity overlapping the premaxillary border. The nostril is nearer the extremity than it is to the orbit. The granular roughening is present on the extremity of the nose, on the posterior part of the vertex, on the eyelid, the pretympanic ridge, and on the parotoid gland. The tongue is narrow and subcylindrical, and the choanæ are large and anterior.

The parotoid glands are subtriangular to round in outline, and are as wide as or wider than long. The warts of the dorsal integument are quite small, and stand nearer together on the sides than on the median region. The derm of the inferior surfaces is not roughened nor granular, except for a short space on the gular region, but is more or less distinctly areolate. The external surface of the arm and of the tarsus and hind foot and of the entire sole is spinulose; on the superior surface of the tibia the spinulose tubercles are mingled with larger tubercles. When the posterior limb is extended the end of the tarsus reaches the anterior border of the orbit, and from that point in a few instances to the end of the muzzle. The first finger is longer than the second. The posterior foot is rather small, and the web is deeply emarginate to opposite the middle of the first (fourth) phalange of the fourth toe. All the toes have a narrow dermal margin to their extremities. Subdigital tubercles not large, single. The two metatarsal tubercles are distinct, the internal quite narrow, and with prominent obtuse extremity; the external rounded, and not presenting a free edge.

In large specimens from Lower California the tubercles are coarser, and the granular rugosities of the head smoothed off. There is a trace

of raised border to as far as above and behind the tympanic membrane, thus imitating faintly the *B. lentiginosus americanus*.

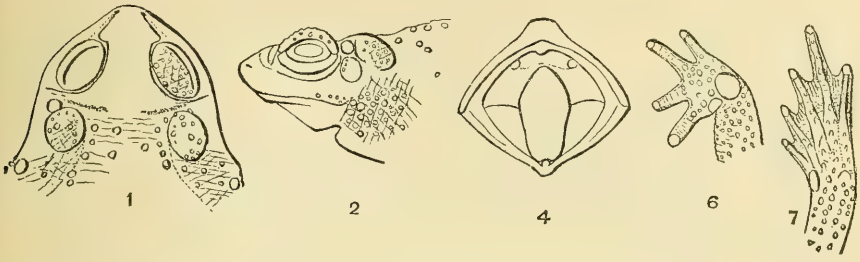


FIG. 60. *Bufo punctatus*. No. 5305. Cape Saint Lucas; ½.

Measurements of No. 2618.

	M.
Length of head and body	.052
Length of head to posterior edge of tympana	.0115
Width of head at posterior edge of tympana	.019
Length of fore limb	.027
Length of posterior limb	.060
Length of tibia	.019
Length of tarsus	.011
Length of remainder of foot	.018

This species is of rather variable coloration. The type (No. 2618) is a uniform light brown above and yellowish-white below. In two other specimens from the same locality the dorsal tubercles are pale, with a dark ring at the base. The latter is the prevalent coloration, for while there are six specimens which show it, there is only one other of the uniform brown tint. Specimens from Cape St. Lucas have red warts, with a black ring at the base, and have the ground color of the sides black besides. The hinder extremities have large blackish blotches, inclosing tubercles which are pink. There is also a black spot on the eyelid, one below the canthus rostralis running longitudinally, and one which extends below and sometimes behind the tympanum.

This is one of our best marked species. Its distribution extends from western Texas from as far north as Fort Concho, and along both sides of the boundary line between the United States and Mexico, to the Pacific ocean. It is found as far south as San Antonio, in Texas (Marnock), and in Lower California to the extremity of the peninsula (Xantus), and in Mexico to Guanajuato (Dugès).

The paired gland-like ridges on the back, represented in the figure of this species in the Report of the United States and Mexican Boundary Survey, are merely the projections caused by the dorsal and sacral diapophyses, somewhat exaggerated.

Bufo punctatus Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2618	3	San Pedro, Tex			Alcoholic.
2617	1	Castanuelas, Mexico		Lieut. B. Couch, U. S. A	Do.
2315	2	Ringgold Barracks, Tex		A. Schott	Do.
2634	1	Sonora		do	Do.
2613	1	Rio San Pedro, N. Mex		Dr. S. W. Woodhouse	Do.
8168	1	Arizona	1871	F. Bischoff	Do.
2614	7	New Mexico		A. Schott	Do.
4103	2	Upper California Region		H. B. Mollhausen	Do.
12661	11	La Paz, L. Cal	1882	L. Belding	Do.
12669	3	do	1882	do	Do.
12670	5	do	1882	do	Do.
10196	1	White River Cañon, Ariz	1879	Dr. R. T. Burr	Do.
12660	3	La Paz, L. Cal	1882	L. Belding	Do.
5305	5	Cape Saint Lucas, L. Cal		John Xantus	Do.

BUFO DEBILIS Girard.

Proceed. Ac. Phila., 1854, 87; Baird, U. S. Mex. Bound. Surv., II, Reptil., p. 27; Boulenger, Cat. Batr. Sal. Brit. Mus , 2 ed., 1882, p. 289.

Bufo insidior Girard, Proceed. Ac. Phila., 1854, 88; Baird, U. S. Mex. Bound. Surv., II, Reptil., p. 26, Pl. XLI, figs. 13–18.

FIG. 61. *Bufo debilis.* No. 2620. Chihuahua, Mex.; ⅔.

This species of toad is nearly related to the *B. punctatus* and agrees with it in most respects. The form of the head and the characters of the skin are quite the same; so is the form of the posterior foot. The differences are well marked, and are as follows: The length of the head is contained in the total more than four times. The first finger is shorter than the second. The hind leg is shorter, the end of the tarsus only reaching the posterior border of the tympanum when the leg is extended. The form and dimensions of the parotoid gland are very different. The gland is very large, extending posteriorly to an acuminate extremity which is a little beyond above the axilla. The superior borders of the glands are divergent, so that the total width at their apices is one and one-half times the width of the head at the tympana. The inferior outline presents the apex of a very obtuse angle downwards at a point posterior to the tympanic drum and on a level with its inferior border. The inferior surfaces are more distinctly granular than in the *B. punctatus*. Metatarsal tubercles insignificant; the internal, subconic.

Measurements of No. 2623.

	M.
Length of head and body	.040
Length of head to posterior edges of tympana	.008
Width of head at posterior edges of tympana	.013
Length of fore limb from axilla	.020
Length of posterior from groin	.040
Length of tibia	.012
Length of tarsus	.009
Length of remainder of foot	.014

The average size is less than that of the *B. punctatus.*

The color of the *Bufo debilis* is a light ash. The small tubercles are generally black, and are without the red or yellow centers seen in the *B. punctatus.* The limbs have narrow black cross-bands, or rather wide incomplete black bands, with the pale center so large as to leave only the black borders. The eyelids and parotoids are crossed by similar black lines. Below and concealed surfaces unspotted.

The range of this species is much like that of the *B. punctatus*, but it extends further east. Mr. Isaac found it on the upper Wichita in Texas, and Mr. W. Taylor at San Diego in southwest Texas. It occurs westward through northern Mexico and the southwest territories to Guaymas, on the Gulf of California. It has not yet been found in Lower California. It was originally brought from the valley of Mexico, and the Smithsonian Institution subsequently received it from Mazatlan. Baird reports it from the lower Rio Grande. It is probably diagnostic of the Sonoran region.

Bufo debilis Girard.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2624	1	Delaware Creek			Alcoholic.
2620	2	Chihuahua, Mexico		Dr. Thomas Webb	Do.
2621	6	Matamoros, Mexico		Lieut. B. Couch, U. S. A.	Do.
2627	1	Matamoros, Mexico		Lieut. B. Couch, U. S. A.	Do.
5381	1	(?)	1860	R. Kennicott	Do.
2619	7	Brazos River, Texas		Dr. B. F. Shumard	Do.

BUFO ALVARIUS Girard.

Baird's Reptilia U. S. Mex. Bound. Surv., II, p. 26, Pl. XVI, figs. 1–6.

This very distinct species is as yet known from a single specimen, which is preserved in the National Museum. It has a general relationship to the *B. punctatus*, and also to the Cuban *Peltaphryne peltacephala* of Cuba. In its large size it equals the *B. marinus.*

Head short and wide; muzzle obtuse and vertical in profile, not projecting beyond upper lip; nares terminal lateral, the canthus rostralis forming a convex line from nares to the orbit. Front wide, superciliary ridges obsolete at anterior third of orbit, moderately elevated behind

this point, and forming a regular curve with the postorbital ridge. No branch crests. A very short robust supratympanic crest, a short narrow preorbital crest. Tympanic disk large, round, its diameter three-fourths the length of the eye-fissure. Tongue elongate-obovate; truncate posteriorly. Border of eyelids thickened, presenting an angle at each extremity, anterior and posterior.

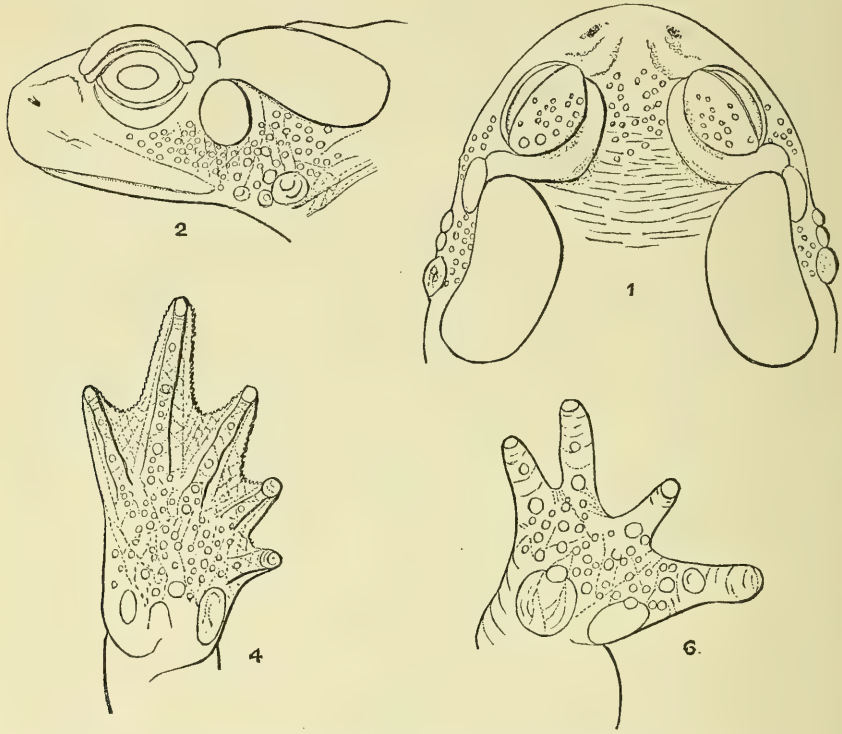


Fig. 62. *Bufo alvarius.* No. 2572. Fort Yuma, Cal.; ½.

Measurements.

	M.
Length of head and body	.165
Length of head including tympana	.036
Width of head, including tympana	.060
Length of fore limb from axilla	.078
Length of fore-foot	.034
Length of hind leg	.051
Length of tibia	.053
Length of tarsus	.033
Length of rest of foot	.053

Parotoid gland a long oval, with parallel sides, descending from the usual commencement above the tympanum to a position above the posterior edge of the humerus, and nearly on a level with the posterior border of the *membranum tympani.* Dorsal integument with rather sparse small tubercles. A huge oval gland on the superior face of the

thigh, and another larger one extending almost the entire length of the superior edge of the tibia. A prominent round wart directly posterior to the rictus oris, preceded by two or three smaller ones. Inferior surfaces areolate, most closely posteriorly.

Fingers short, first and third equal, fourth shortest. Second (first) finger with a very large tubercle at the base of the proximal end of the second phalange; a smaller one in the same position on the second. The usual two large palmar tubercles; distal to which the entire palm is covered with closely placed tubercles. Toes webbed to the extremities, but the web scalloped, so that the edge between the third and fourth toes is opposite the extremity of the first phalange (from metatarsal). Sole with a pavement of rather small warts, a single rather larger one below the proximal extremity of each phalange excepting the distal ones. External metatarsal tubercle large, little defined; the internal small, oval, and with free conical extremity. Its inner edge is close to a free dermal margin, which extends from the edge of the first toe and turns forwards on the tarsus and is lost distad to its middle. When the hind leg is extended the heel reaches the middle of the tympanum and the end of the tarsus reaches the extremity of the muzzle.

The length of the head is considerably less than its width, and enters the total length nearly four times; or, measuring from the supraoccipital line, four and a half times.

The color of the specimen is probably somewhat paler than normal from the effect of the alcohol. Girard states the fresh color to have been "uniformly dark green." At present it is light brown, and below whitish, with a few pale spots on the thoracic and gular regions. Thighs uniform light brown behind.

The figure of this species given by Baird, as above cited, is good, except that the parotoid gland is represented as too wide. This gland in this species is quite peculiar in its form and position.

No. 2572; one spec.; Fort Yuma, Cal.; A. Schott.

BUFO COLUMBIENSIS Bd. & Gird.

Bufo columbiensis Baird & Girard, Proc. Ac. Phila., 1853, p. 378; Girard, *l. c*, p. 77, Pl. 5, fig. 4–9; Cope, Check List Batr. Rept. N. Amer., 1875, p. 29.

Bufo boreas Baird & Girard, Proc. Ac. Phila., 1852, p. 174; Girard, U. S. Expl. Exped., Herp., p. 74, Pl. 6, fig. 4–9; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 296, fig.

Bufo halophila Baird & Girard, Proc. Ac. Phila., 1853, p. 301; Girard, Proc. Ac. Phila., 1854, p. 87, and U. S. Mex. Bound. Surv., II, p. 26, Pl. 41, fig. 7–12; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 295, fig.

Bufo chilensis, part, Günth., Cat. Batr. Sal. Brit. Mus., 1868, p. 57.

Bufo microscaphus Cope, Proceed. Ac. Phila., 1866, p. 301; Report U. S. G. G. Expl. W. of 100th Mer., G. M. Wheeler, v. p. 522.

Bufo pictus Cope, Report U. S. G. G. Expl. W. of 100th Mer., v., p. 522, Pl. xxv fig. 4–5.

This is a variable species, so much so as to present the appearance of including a number of subspecies. But these intergrade in so many specimens that I can not maintain them as distinct, and I shall use the term variety as more applicable to their case.

The head is short and wide, and its length varies so as to enter from four to four and a half times in the total length. The extended hind leg brings the heel to the posterior lower or middle of the orbit. The muzzle viewed from above is rounded, and in profile is truncate, and not projecting beyond the premaxillary border. It is shorter than the length of the orbit, and the nostrils are terminal. The tongue is flat and thin, and is a long oval in outline. The *membranum tympani* is quite distinct, and is subround. Its diameter is a little less than half the length of the eye slit. The parotoid gland varies in form from nearly round to a moderately elongate-oval; in either case it has an anterior prolongation to the border of the orbit. The glands of the integument of the upper surfaces vary from moderate to large size. They are smaller on the sides and on the limbs, excepting a large oval one on the superior face of the tibia. The inferior surfaces are coarsely areolated, with a few more distinct tubercles posteriorly. There is an infolded ridge on the inner edge of the tarsus. The posterior foot varies in relative width in different individuals and localities. In northern specimens the sole is wider, and the palmation extends to the ends of the toes. It is emarginated, so that the edge is

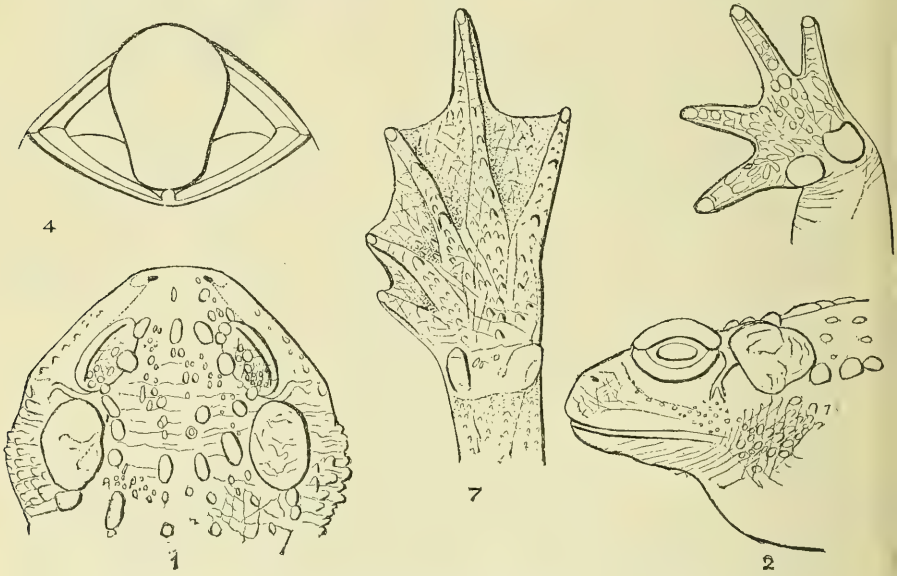


Fig. 63.—*Bufo columbiensis columbiensis.* No. 11516. Kewakin Valley, W. T.; ½.

Measurements of No. 328.

	M.
Length of head and body	.124
Length of head to posterior edge of membranum tympani	.021
Width of head at posterior edge of membranum tympani	.034
Length of fore limb	.061
Length of posterior limb	.116
Length of tibia	.039
Length of tarsus	.024
Length of remainder of foot	.045

opposite the middle of the third phalange of the fourth toe, counting from the end. In the extreme southern form the web does not extend to the extremities of the digits, but leaves three phalanges of the fourth toe absolutely free. It is notched to a point a little proximal to the distal end of the fourth (first) phalange. Between these extremes of palmation (represented by specimens 328 and 2581) all the intermediate conditions may be found. The internal metatarsal tubercle is small and narrow, with subconical extremity; the external is a low but rather wide tuberosity. The first finger is longer than the second.

The northern forms are sometimes of a uniform olive-brown above, with a pale vertebral line, and with the abdomen indistinctly spotted. Sometimes the uniform brown extends for a short distance on each side of the pale vertebral line, exterior to which the surface has large brown spots on a light olive ground. In the southern forms the ground color is light brown or olive, or even clay color, with an irregular brown band on each side of the light vertebral line. On each side are large dark brown spots with a reddish wart for a center. Spots on the posterior legs like those on the back. Below unspotted.

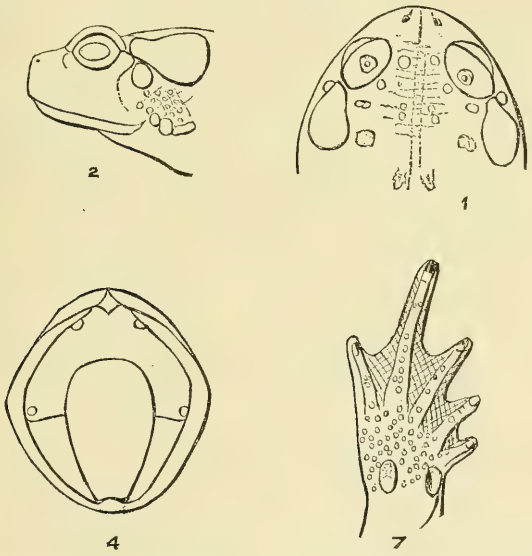


FIG. 64.—*Bufo columbiensis halophilus* (from Baird, U. S. and Mexican Bound Survey); 1.

The northern and southern varieties may be thus defined in extreme forms:

Head 4.5 times in length; web extending to tips of toes, but deeply emarginate; parotoid gland more elongate; colors dark; size large ..... *B. c. columbiensis.*

Head 4 times in length; webs more deeply notched, and leaving three phalanges of fourth toe free; parotoid shorter; colors light; size smaller ..... *B. c. halophilus.*

There are, however, as many specimens which are intermediate between these extremes as there are specimens of the latter. These represent the *Bufo microscaphus* Cope. The specimens of the middle and southern Rocky Mountain region are referable to it, as well as many from

Oregon and California. I think *B. pictus* is the young of this form. To the typical *B. columbiensis* belong Nos. 328, 2577, 2579, 4975, 9950, 10920, and 11516. To the intermediate type belong 9636, 8093, 11500, 11922, and 11923. To the halophilus type may be referred Nos. 2581, 9465, 11535, 11921, and 11922. No. 11505 is intermediate in the form of the parotoids, and the web is deeply excavated, but the free portion of the toes are widely margined. A complete series of the forms of the parotoid may be traced, beginning with the short type of halophilus, No. 2581, through 13608, 11505, 11535, to 11923 of the elongate form.

In Nos. 4975 and 9950 there are distinct traces of superciliary cranial ridges. They are perfectly straight, and there is no indication of postorbital ridges. There are four specimens under 4975, and they are from Chilowyuck, Wash. Ter. The locality of the other specimen is unfortunately unknown. The same character is seen in the type of *B. microscaphus*, according to my description, which is given below. The specimen is unfortunately inaccessible to me at present.

"Upper surface of head nearly plane upon its middle region; orbits bordered by a low and rounded off ridge; its skin being thin and adhering to the skull. Parotoids well developed and subreniform. Eyes and tympanum rather large. Tongue elongated, broadest posteriorly. Upper jaw emarginated. Two large carpal callosities. A membranous fold at the inner lower edge of the tarsus. Toes palmated; two metatarsal tubercles. Palms and soles coarsely granular. Upper surface of body exhibiting numerous glandular tubercles; large pustular swelling upon the thighs. Color uniformly dark green."

I also add a copy of my description of the young, under the name of *B. pictus*, as it embraces some peculiar characters, probably due to immaturity:

"Palmar and solar tubercles well developed, the larger or inner one of the latter not bearing a cutting edge. Cranium plane above; the muzzle produced, rather narrowed, and vertically truncate. *Membranum tympani* very small, externally invisible; ostia pharyngea exceedingly minute. Tongue large, oval, extensively free. Parotoids superior, broadly oval in form. Upper surfaces covered with large tubercles; inferior surfaces areolate. Limbs stout, especially the tarsus, which bears a longitudinal fold. The heel reaches to the middle of the parotoid gland, and the toes are only webbed at the base." The palmar and solar tubercles are yellow, and the warts of the body tipped with red; size small.

There is a direct relation between the climatic conditions of the regions and the forms of this species which inhabit them. It is well known that the degree of humidity of the Pacific region increases rapidly as we pass from south to north. The southern part of the region inhabited by this toad is quite arid, and the opportunity for aquatic life must be limited. Accordingly the natatory web of the hinder foot is reduced. In the specimens from the rainy north the web is much larger and the colors are darker. This increase of pigment is confirmatory of J. A.

Allen's hypothesis, based on observations made on mammalia and birds, that dark pigment increases with increase of humidity.

In its eastern distribution this species is not known to pass the limits of the Rocky Mountains. Capt. Charles Bendire, U. S. Army, has sent it from Fort Walla Walla, Wash. Ter., and I took it at Atlanta, Idaho, the most eastern locality known. It is abundant throughout the entire lake region of Oregon.

It is especially numerous at Klamath Lake, where it covers the basaltic blocks which lie partially in the water, concealed by the Typhæ, which grow from the bottom. They accumulate there in large piles, sometimes as large as a bushel measure, and afford abundant food for the Eutæniæ, which are scarcely less abundant. I saw one specimen of this toad as large as the average *Bufo marinus* of Brazil, and a specimen seen at Warner's Lake, Oregon, was but little smaller.

Bufo columbiensis Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2579	1	Medicine Bow Creek		Dr. W. A. Hammond	Alcoholic.
4104	6	Columbia River, Oreg		H. B. Mollhausen	Do.
4975	5	Chilowyuck Lake, Oreg.		Dr. C. B. R. Kennerly	Do.
2628	1	Fort Umpqua, Oreg		Dr. E. Vollum, U. S. A	Do.
4792	1	Simahmoo Bay, Wash		Dr. C. B. R. Kennerly	Do.
2577	1	Shoalwater Bay, Oreg		Dr. J. G. Cooper	Do.
2574	10	Cape Flattery, Wash			Do.
2590	1	Monterey, Cal		A. S. Taylor	Do.
2581	1	San Diego, Cal		Dr. J. L. Le Conte	Do.
2586	2	do		Dr. Thomas Webb	Do.
2589	2	Benicia, Cal		Dr. J. L. Le Conte	Do.
2585	1	San Diego, Cal		Dr. Thomas Webb	Do.
2584	1	Presidio, Cal		Lieut. W. P. Trowbridge, U. S. A.	Do.
9465	6	Fort Tejon, Cal		J. Xantus	Do.
8691	1	Santa Barbara, Cal	July—, 1875	H. W. Henshaw	Do.
8678	10	do	July—, 1875	do	Do.
8696	1	Lake Tahoe, Cal	1876	do	Do.
8695	1	Virginia City, Nev	1875	William Seckels	Do.
8681	10	Lake Tahoe, Cal	Aug.—, 1876	H. W. Henshaw	Do.
11941	1	Des Chutes River, Oreg	1878	do	Do.
13608	2	San Diego, Cal		C. R. Orcutt	Do.
9941	1	Shoshone Lake		Dr. Curtis	Do.
11535	1	(?)		(?)	Do.
11921	1	Monterey, Cal		—— Jordan	Do.
11922	5	Northern boundary	1874	Dr. E. Coues	Do.
11942	8	Oregon	1878	H. W. Henshaw	Do.
7016	1	Simahmoo Bay, Wash		C. B. R. Kennerly	Do.
11953	12	Fort Tejon, Cal		John Xantus	Do.
11505	1	Fort Walla Walla, Wash.	1881	Capt. Charles Bendire	Do.
9636	2	South Park, Colo		J. T. Rothrock	Do.
11923	1	Northern boundary	1874	Dr. E. Coues	Do.
9950	1	Iowa		R. Kennicott	Do.
11516	1	Kewakin Valley	1878	H. W. Henshaw	Do.
10920	2	Fort Walla Walla, Wash.	1881	Capt. Charles Bendire	Do.
8655	1	Utah		Dr. H. C. Yarrow	Do.
11500	2	Camp Bidwell, Cal	1878	H. W. Henshaw	Do.
11742	1	Upper Humboldt Valley	1867	Robert Ridgway	Do.
8506	6	Crittenden, Ariz		J. M. Rutter	Do.
2573	1	Shoalwater Bay, Wash		Dr. J. G. Cooper	Do.
11519	1	(?)		(?)	Do.
6278	5	Clark's Forks, Kootenay River.		C. B. R. Kennerly	Do.
7144	2	Fort Crook, Cal		D. F. Parkinson	Do.
11946	7	Bidwell, Cal	1878	H. W. Henshaw	Do.
2578	1	Upper Pit River, Cal		J. S. Newberry	Do.
4568	12	Fort Tejon, Cal		J. De Vesey	Do.
4194	2	Fort Bridger, Utah		C. Drexler	Do.
13793	1	Baird, Shasta County, Cal.	1884	C. H. Townsend	Do.
13794	1	do	1884	do	Do.

BUFO COMPACTILIS Wiegm.

Isis, 18[illegible], p. 661; Peters, Mon. Berl. Ac., 1863, p. 89, and 1873, p. 624; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 302.

Bufo speciosus Girard, Proceed. Ac. Phila., 1854, p. 86, and U. S. Mex. Bound. Surv. II, p. 26, Pl. 40, fig. 5–10.
Bufo anomalus Günth., Cat. Batr. Sal. Brit. Mus., 1868, p. 57.
Bufo cevifrons Bocourt, Bull. Soc. Philom. (7), I, p. 187.
Anoplectrus anomalus Camerano, Atti. Acc. Tor., XIV, p. 882.

Head moderate; its upper surface smooth and even, else showing slight traces of superciliary ridges. Snout much shorter than length of orbit, subtruncated and rounded; nostrils subterminal. Mouth large; upper jaw slightly emarginated. Tongue more widely oval than usual in the genus; flat; free posteriorly for the fourth of its length. A subgular vocal bladder in the male sex. Tympanum distinct, of medium size. Parotoids one-half length of eye-fissure, rather small, oval, not reaching orbit. Limbs of moderate development, end of tarsus reaching tympanum. First finger much longer than the second, which is equal to the fourth. A large subcircular carpal disk. Toes semipalmated, leaving two and a half phalanges of the fourth toe free. Two metatarsal spade-shaped processes, the innermost being much the largest, both furnished with a black cutting edge. Inner lower edge of the tarsus acute, not incurved. Skin above covered with numerous and closely placed papillæ of moderate development, and indistinctly areolated beneath; no large gland on tibia. Color above greenish-brown, with or without a few brown spots; no dorsal lighter vitta or streak. Beneath greenish or yellowish-white, unicolor.

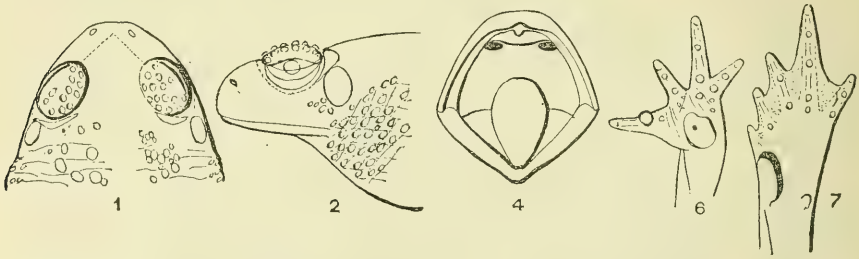


Fig. 65. *Bufo compactilis*. No. 2608. Ringgold Barracks, Tex.; ½.

Measurements of No. 2627.

	M.
Length of head and body	.072
Length of head to posterior edges of membranum tympani	.016
Width of head at posterior edges of membranum tympani	.024
Length of anterior limb from axilla	.038
Length of posterior limb from groin	.066
Length of tibia	.025
Length of tarsus	.015
Length of rest of foot	.025

The above measurements of the posterior leg show that the greater part of the femur is embraced in the integument of the body.

This toad has very much the appearance of one of the Scaphiopidæ, and it is not unlikely that its habits are, like theirs, subterranean.

The specimen figured as *Bufo speciosus* by Baird in the Report of the Mexican Boundary Survey (No. 2611), from Pesquiera, in Nuevo Leon is not typical of the *B. compactilis*. It has feeble traces of the crania crests of the *Bufo cognatus*, and some large brown dorsal spots not found in other specimens. Three specimens from Kansas (3994) possess similar rudimental crests, and a fifth specimen of the same character was sent me from the Wichita River, in central northern Texas, by Jacob Boll. These specimens foreshadow the characters of the *Bufo cognatus*, while not approaching it in the development of the cranial crests. In the Dallas specimen the dorsal spots are of medium size, while in those from Kansas they are very small or wanting. I suspect that the cranial characters belong to a race which ranges farther north than the true *Bufo compactilis*, which may at some time be regarded as a subspecies, under the name of *B. compactilis speciosus*. The true *B. compactilis* occurs in southwestern Texas, and ranges as far south in Mexico as the Isthmus of Tehuantepec.

Bufo compactilis Wiegm.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2652	2	Indianola, Tex		Capt. John Pope, U. S. A.	Alcoholic.
2654	5	Encinella		Dr. Thomas Webb	Do.
2612	1	Between Salado River and Camargo.		A. Schott	Do.
2609	3	Point Isabel		G. Wurdemann	Do.
2627	1	Fort Bliss, N. Mex		Dr. S. W. Crawford, U. S. A.	Do.
2611	1	Pesquieria Grande, N. Leon.		Lieut. B. Couch, U. S. A.	Do.
2610	1	Brownsville, Tex		Capt. Stewart Van Vliet, U. S. A.	Do.
2608	1	Ringgold Barracks, Tex.		A. Schott	Do.
11494	1	Texas		George B. Sennett	Do.
2627	1	Matamoros, Mexico		Lieut. B. Couch, U. S. A	Do.
4994	2	Kansas		R. Kennicott	Do.
4964	3	Pecos River, Texas		Capt. J. Pope	Do.

BUFO HEMIOPHRYS Cope.

Proceed. Amer. Philosoph. Soc. 1887, p. 515.

Superciliary crests not distinct on the muzzle, parallel, nearly straight, terminating abruptly posteriorly in a transverse elevation. The latter meet on a middle line, forming a transverse ridge, with an abrupt descent to the nape. Externally they extend but a short distance, leaving no representations of the postorbital ridges except a few tubercles in one or two of the specimens. A small supratympanic tuberosity. No preorbital ridge. Muzzle vertical at end; nostrils terminal. Membranum tympani a vertical oval, two-thirds the diameter of the eye. Parotoid

gland a narrow oval. Dermal tubercles distinguished by their small size and prominence. They form several rows on the back and external face of the tibia. At all other points the skin is closely areolated, the areolæ frequently acutely prominent, especially on the superior face of the tibia and on the sides. The heel of the extended hind leg reaches to the posterior border of the orbit. The posterior foot is wider than in the *B. lentiginosus*, though not relatively shorter. The web is excavated to the line of the middle of the fourth (first) phalange. The metatarsal tubercles are especially large. The internal is very wide and prominent, and has an extensive acute edge; the external is much smaller, but it also has a free cutting edge transverse to the length of the tarsus. The length of the head to the position of the postorbital crests enters the total (to the vent) four and a half times.

The color is brown, marked on the back with a median yellowish line, and two or three rows of brown spots of median size on each side of it. These spots have one or two tubercles for their center pieces, which are more reddish than the rest of the spot. There are two brown spots on the upper lip and one below the tympanum. A large spot extends from below the parotoid gland to near the front of the humerus. Posterior to this, with a light interval, there extends a longitudinal deep brown band, which extends, with interruptions, to the groin. Below this on the sides are other dark brown bands, which form a more or less reticulate pattern. The limbs and posterior feet have dark brown cross-bands, and there is a very coarse dark brown reticulation of brown or brownish-yellow on the posterior face of the femur. The belly is more or less black spotted; throat immaculate.

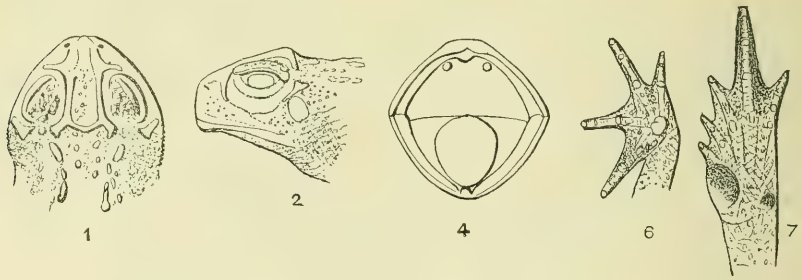


FIG. 66. *Bufo hemiophrys*. No. 11927. Northern Montana; ¾.

Measurements of No. 11927.

	M.
Length of head and body	.059
Length of head to posterior edge of membranum tympani	.015
Width of head at posterior edges of membranum tympani	.023
Length of anterior limb	.034
Length of anterior foot	.014
Length of posterior limb	.068
Length of tibia	.020
Length of tarsus	.010
Length of rest of foot	.025

Besides the peculiarities of the head crests and metatarsal shovels, this species differs from most of the other North American species in having the belly spotted.

No. 11927; 7 specimens; northern boundary United States, Montana; 1874; Dr. E. Coues.

Of the above specimens four are adult or nearly so, and three are half grown.

BUFO COGNATUS Say.

Long's Expedition to the Rocky Mountains, II, 1823, p. 190; Holbr. N. A. Herp., v. 1842, p. 21, Pl. v.; Bd., & Gird., Marcy's Report, 1853, p. 242, Pl. 11; Report U. S. Pac. R. R. Surv., x, Whipple's Report, p. 44, Pl. xxvi.

Bufo dipternus Cope, American Naturalist, XIII, p. 437; Boulenger, Cat. Brit. Mus., 1882, p. 308.

Head short, one-fifth the total, measured over the dorsal convexity; wide, and with muzzle descending steeply. The descent commences between the anterior part of the orbits, sloping to opposite the nares, below which it retreats a little within the perpendicular to the upper lip. The entire prefrontal region to a point which measures the anterior third of the orbit projects as a flat boss or protuberance. The superciliary ridges of the frontoparietal bones originate from the posterior side of this, and diverge rapidly, passing by a regular curve or a very open angle into the postfrontal ridge. At the point of junction there is on the inner side an angular tuberosity, which represents the continuation of the superciliary ridge. There is no disposition to the connection of these angles across the middle line or the filling up of the included groove, as is seen in *B. hemiophrys*, *B. lentiginosus woodhousi*, etc. The prefontal boss forms an elevation along the front of the orbit, but not a distinct crest. Supratympanic crest represented by an angle only. Membranum tympani a vertical oval, quite distinct, its long diameter one-half that of the orbit, sometimes one-third. Owing to the elevated form of the muzzle, the nostril marks a point half way between its summit and the edge of the upper lip, and the eye-fissure runs obliquely downwards and forwards.

The parotoid glands are short and wide, generally a short oval in form, at other times subtriangular. The dorsal integument is covered with very numerous closely placed small tubercles, which continue, with diminished dimensions, on the sides and lower surfaces everywhere. No large glands intermixed. First finger a little longer than second. Toes webbed, the web reaching the middle of the fourth (first) phalange. Sole wide, width at second toe inclusive, one-half of length from between metatarsal tubercles. The latter are large, the internal extensively free and presenting a wide cutting edge. The external is larger than usual and wide, with a free cutting edge. The subarticular tubercles are small. On the fourth toe they are sometimes double.

Measurements of No. 11578.

	M.
Length of head and body	.084
Length of head to posterior edges of tympana	.012
Width of head to posterior edges of tympana	.038
Length of fore-leg	.044
Length of fore-foot	.021
Length of hind foot from groin	.091
Length of tibia	.030
Length of tarsus	.020
Length of rest of foot	.031

The above measurements of the hind foot leave only 10mm. for the femur, measured from the groin. This is due to the fact that that segment is almost entirely included in the integument of the body, and much more extensively than in any other North American species. The tarsometatarsal joint reaches to the orbit when the hind leg is extended.

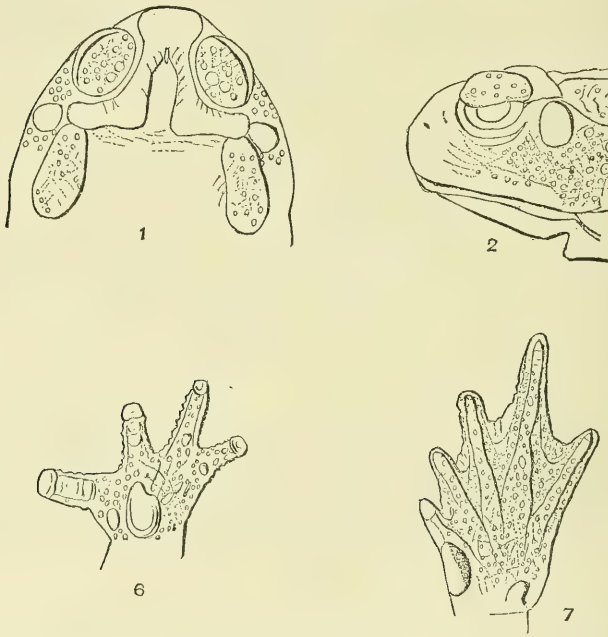


FIG. 67. *Bufo cognatus.* From Baird, U. S. Mex. Boundary Survey.

The body is dusky brown above, and is covered with small black warts, which are most numerous and prominent near the sides. A yellowish-brown vertebral line extends from the head to the rump, from which proceed oblique lateral lines of the same color. The first oblique lateral line begins at the head and runs to the side behind the shoulder; the second begins near the middle of the back by two branches, which soon unite and run to the groin; a third line begins still farther back, and extends to the hips.

The abdomen is dingy yellowish-white. The anterior extremities are

dusky brown above and dingy white below. The posterior extremities are colored, like the back above, with bars of yellowish-brown, and are dingy white below.

After a study of the numerous specimens in the collection of the National Museum, I am convinced that this species is entitled to full recognition. The differences from the *B. lentiginosus*, its nearest ally, are numerous. These include the form of the cranial crests, the shape of the parotoid glands, and the development of the metatarsal spurs. It is also easily recognizable by the coloration.

What I believe to be a large young specimen of this species served as the type of my *Bufo dipternus*. Although an inch and a half long, this individual had not developed a trace of the cranial crests. The dorsal spots also are smaller than in any specimen I have seen. I obtained two other specimens of about the size of the type and three smaller ones near the Judith River, Montana.

This is chiefly a species of the plains; but it extends into the Rocky Mountains also.

Bufo cognatus Say.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4183	2	Colorado River		Mollhausen	Alcoholic.
4366	8			Dr. Webb	Young.
2563	1	Pole Creek, Ark	July 9, 1857	W. S. Wood	Alcoholic.
2562	1	Red River, Ark		Capt. R. B. Marcy	Do.
2561	2	Fort Pierre, Nebr		Dr. Evans	Do.
2635	10	Salt Plains		J. H. Clark	Do.
2567	1	Fort Riley, Kans		Dr. W. A. Hammond, U. S. A.	Do.
5234	1	Kansas		R. Kennicott	Do.
2564	2	Coahuila, Mexico	1853	Lieut. B. Couch, U. S. A	Do.
2566	6	Sand Hills		Dr. F. V. Hayden	Do.
8507	2	Fort Garland, Colo	July 23, 1873	H. W. Henshaw	Do.
4626	1	Nebraska		Capt. J. H. Simpson, U. S. A.	Do.
9429	1	Fort Garland, Colo			Do.
9428	1				Do.
2565	3	Little Blue River, Kans		Dr. J. G. Cooper	Do.
9476	1	Ralston, Ariz		Dr. C. G. Newberry	Do.
4180	2	Near Colorado River		do	Do.
11578	8	Fort Kearny, Nebr		W. S. Wood	Do.
9450	1	California	1877	Dr. J. G. Cooper	Do.

BUFO LENTIGINOSUS Shaw.

Zoology, 1803, III, I, p. 173, tab. LIII; Günth. Cat. Batr. Sal. Brit. Mus., 1868, p. 63; Cope Check List Batr. Rept. N. Am. 1875, p. 29, parte maj.; Boulenger, 2d ed., Catal. Batr. Sal. Brit. Mus., 1882, p. 308.

Cranium with distinct osseous crests, which form straight lines, one over each orbit, which is continued posterior to it for a short distance. A postorbital crest extends at right angles to the supraorbital, and presents an obtuse angle or a short ridge posteriorly at the superior border of the tympanic disk. No considerable crest directed inwards from the

extremity of the supraorbital. Tympanic disk distinct; vertically oval in form; its long diameter two-thirds that of the orbit. Parotoid gland elongate, with oval extremities; not angulate nor descending on the sides of the body. Dorsal derm studded with rather small round warts. Surfaces of limbs and lower parts everywhere strongly granular. First finger a little longer than second. Toes webbed, the membrane emarginate to opposite the middle of the fourth (first) phalange, leaving the distal phalanges with a dermal margin only. Metatarsal tubercles two; the internal large, narrowed, and with a short free cutting edge; the external small and without cutting edge. The length of the head to the posterior extremity of the longitudinal crests enters the total length from three and a half to five times, differing in the subspecies.

The color of the species is brown above, with darker brown subround dorsal spots with pale edges and of moderate size, arranged in from two to four rows on each side of the middle line. The latter is generally marked by a more or less distinct pale streak. There is frequently, but not always, a dark brown lateral shade, which commences below the posterior end of the parotoid gland, and has a pale superior, but no distinct inferior border. It may be broken into spots. The limbs are brown, cross-banded, and the inferior surfaces are pale yellow, which is very rarely dark spotted, and then only on the thorax.

The size varies from three to five inches in length of head and body.

In its distribution this species is one of the most widely diffused of the cold-blooded vertebrates of North America, and as such presents several strongly marked geographical subspecies which have been regarded as species. That the latter view can not be maintained is evident from the existence of a small minority of individuals in which the features of the respective types are found to be wanting or mingled. The persistence of these forms is, however, so evident, that they should take distinct rank in our system. Their definitions are as follows:

Frontoparietal crests approximated, parallel, not produced; postorbital crests long; no supratympanic crest; head 4 to 4.5 times in length ..... *B. l. fowleri.*

Frontoparietal crests parallel, not well distinguished posteriorly on account of the abrupt elevation of the occiput; postorbitals long; no supratympanic; head 4.5 to 5 times ..... *B. l. woodhousei.*

Frontoparietal crests divergent, not much produced, and well distinguished behind; postorbitals short; supratympanic wanting or short; head 4 to 4.5 times in length ..... *B. l. americanus.*

Frontoparietal crests divergent, produced into a knob behind the short postorbitals; supratympanic well developed; head 3.5 to 4 times in length ... *B. l. lentiginosus.*

The *B. l. americanus* is the central form from which the others radiate. The *B. l. lentiginosus*, as the characteristic type of the Austroriparian region, has characters most divergent from the others. The peculiar form *B. l. fowleri* of the Northeast is connected with the other types by the *B. l. woodhousei* of the Rocky Mountains. The latter is the most difficult to separate from the eastern *B. l. americanus*, though its typical representatives are quite distinct.

Bufo lentiginosus fowleri Putnam.

MSS., Cope, Check List N. Amer. Batr. and Reptil. 1875, p. 29. (name only).

This animal, like the *B. l. woodhousei*, is distinguished by the gradual and steep elevation of its cranial crests and lack of supratympanic ridge. It differs from it in the approximation and posterior confluence of these ridges, the greater breadth of the parotoids, and in coloration. Supraorbital ridges elevated, rising posteriorly close together, parallel or convergent behind, inclosing a frontoparietal gutter; postorbital ridges curved backward; no parietal tubercle, but a cross ridge or median elevation; no supratympanic ridge. Canthus rostralis very obtuse, a central groove on top of muzzle; premaxillary margin retreating. A preorbital ridge; supraorbitals high, thin, sometimes divergent a little in the middle; then convergent again, prolonged a little beyond postorbital, and connected by a lower transverse ridge. Postorbital curved backwards to meet the parotoid; latter elongate-oval, as long as vertical groove to nares. Nostrils equidistant from eye slit and labial margin; latter nowhere produced. Tympanum distinct, half orbit. Muzzle to middle of extended fore-arm; heel beyond muzzle; metatarsal shovel strong, narrow; outer tubercle minute. Toes half webbed, width of sole at second toe one-third length from outer tubercle. Choanæ and ostia pharyngea equal. Color grayish-olive, sometimes quite bright, with a yellowish vertebral line from the end of the muzzle. Six spots of six pairs on each side of this; two pairs superciliary, one nuchal and three dorsal, all elongate, deep brown, yellow margined. Three from orbit; one below, two behind, the superior above tympanum, deep brown, yellow edged. Below, dirty white; throat of male in spring black; sides behind and femora marbled with yellow on blackish ground. Length of head to postorbital crest $4\frac{2}{3}$ in total length; latter equal 2 inches 6 lines. Elevation of cranium 6.7 lines. Fore limb 1 inch 8 lines; hind limb 3 inches 5 lines, femur half included.

This subspecies is so far known only as a native of a few ponds in northeastern Massachusetts near the town of Danvers. Such a limited distribution for a land vertebrate is remarkable, as is also the fact of its having so long remained without introduction to science. It has been known and noticed by scientific men of the neighborhood, it seems, for twenty years. I append a letter of its only historian, S. P. Fowler, to my friend F. W. Putnam, whose name the latter has conferred on it.

Among eighteen specimens of this subspecies forwarded to me by the Essex Institute of Salem, one female exhibits widely separated superciliary ridges; in a nineteenth, from New Harmony, Ind., the ridges are a little more divergent and less ascending, with scarce a trace of the median supraparietal elevation. A specimen of the var. Americanus from Nebraska approximates sufficiently closely to the last specimen to indicate that the Fowleri can not be regarded as under all circumstances separate or be accorded full specific rank.

Bufo lentiginosus fowleri Putnam.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
10885	1	Danvers, Mass		Prof. F. W. Putnam	Alcoholic.
10886	1	do		do	Do.
10887	1	do		do	Do.

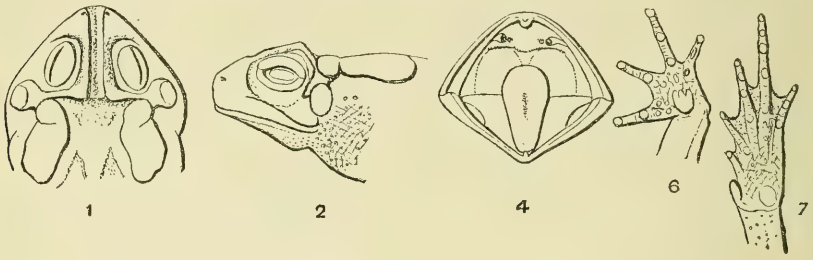


FIG. 68. *Bufo lentiginosus fowleri*, Putn. 10888. Danvers, Mass.; ¼.

Mr. S. P. Fowler, of Danvers, Mass., after whom this interesting toad was named, makes the following statement in regard to the habits of *B. lentiginosus fowleri*, in a letter to Prof. F. W. Putnam, who has kindly allowed me to make the following extract from it:

"In regard to its habits I would say I have never been able as yet to discover it except in warm summer evenings when the thermometer is not below 60°. In cool evenings they are not to be seen at all and are perfectly silent. When first observed in the *early* part of the evening they may be seen making their way through the grass and over the grounds adjacent to the pond, and when it is reached, which is usually about dark, they commence their singular note, which the late Dr. Nichols thought was amatory, and which he described as a shrill monotone, continued a second or more in a high falsetto voice, thrice as long and more trilling than the voice of Pickering's Hyla. I agree with Dr. Nichols in regard to the croak of this toad, excepting the trill, there being no trill to this reptile's note, such as we notice in the common toad, frequently long continued, and which seems to mark this species. I would here say I have heard the note of one toad in the grass some distance from the pond. To my ear this croak is a sharp, disagreeable, unearthly *screetch*, difficult to describe, as it is unlike any sound I have ever heard uttered. I have heard people who live near this pond (Judge Putnam's) say that they thought it resembled in a warm summer's night (when they are most active and numerous) the whoop of a party of Indians, and that they have heard their screeching during the whole night. That their note is amatory I have at present some doubt, as it is continued through the warm season of the year. I first noticed these toads the present season at Judge Putnam's pond, in the evening of 20th of May, when I took several of them. I have not as yet been able

to find what I consider their spawn, nor have I seen any copulation among these toads, so often noticed among the common species. I have seen them in this pond as late in the season as the last of August. There are several ponds in the vicinity of the judge's pond, but they are not visited by these toads, but I have seen them in small numbers in clay pits. I have a pond in my grounds that swarms in May with the common toad, but is never visited by the one under consideration. I have not noticed the common toad around this pond, but I now intend to make a search for it. In answer to your question, 'What length of time have these toads been observed in this pond?' I would say I have noticed them in this pond thirty-five years. In regard to their food, I think it is different from that of the common toad, as they will not eat earth-worms, but feed readily upon flies. This habit I have noticed, as well as my brother Augustus, he having kept them for some months for the purpose of painting them, and who has furnished me with several figures of this reptile in different attitudes. I have noticed when these toads are held in the hand they make a chirping noise, and when a dozen or more are confined together they make considerable noise. Perhaps the same may be noticed in the common toad during the breeding season. It is very singular that those I sent you were all *males;* they were all croakers, that is certain, for by their note I was led to know where to take them in the dark. I have always been puzzled to know why these toads visit this pond during the whole warm season. So far as I have been able to judge it is for the sole purpose of croaking, for they do nothing else, or to wet their skins. The common toad is found everywhere, and breeds in all the still and quiet waters in the country, whereas this supposed new species is discovered in a very few ponds, and is comparatively scarce. I have thought that this toad was of a more spare habit, if I may so speak—not so heavy or corpulent as the common toad, more active, as much so as the frog, and full as difficult to catch. I think there is more uniformity of size and color than we see in the common toads. I do not recollect in the great numbers I have examined to have seen a small one or one differing in color from another. The difference in size and color is very great amongst our common toads. I have said in the vicinity of this pond I have frequently heard their note some distance from the water at the same time others were croaking in the pond. I have never observed this anywhere else in my walks in the evening."

Bufo lentiginosus woodhousei B. & G.

Bufo woodhousei Girard, Proceed. Ac. Phila., 1854, 86; Baird, U. S. Pac. R. R. Repts. p. 44, Pl. xxv, fig. 1.

Bufo frontosus Cope, Proceed. Ac. Phila., 1866, p. 301; Rept. Expl. U. S. Surv. W. of 100 Mer., G. M. Wheeler, 1877, v, p. 520, 627.

This subspecies may be readily distinguished by its short head with thickened crests elevated posteriorly. It reaches a larger size than either of the other subspecies of the *Bufo lentiginosus.*

The canthus rostralis not marked, the muzzle descending very steeply from the anterior angles of the orbits, shorter than the elevated perpendicular extremity. Frontal ridges thickened, frequently partially filling the median groove, higher than eyelids, and rising steeply backwards, where they terminate in two short convergent tuberosities, with interior crenations. Occiput generally raised above the nape; postocular ridge equally developed, sending a small angle to the anterior acuminate extremity of the parotoids. Elevation of cranium at parietal tubercle equal to length of same from the same point. Eyes large; tympanum distinct; half eye; parotoid narrow, long, acuminate at both ends. Elbow to anterior margin of orbit; heel to end of muzzle. Skin everywhere with numerous small tubercles; soles rough; toes half webbed, as in the other subspecies. The internal metatarsal tubercle is distinctly larger, *i. e.*, wider, than in the other subspecies, almost equaling that of the *B. cognatus*. The external tubercle is also larger than in the other forms, but it never possesses a free cutting edge as it does in the *B. cognatus*. The relative shortness of the head is expressed by the measurement, one-fifth the length of the head and body. This character is, however, not constant. Thus in the typical specimens of the species (No. 2632, Canadian River) the head enters 4.66 times into the length. The same is true of Nos. 14526 and 10195. In Nos. 4185 and 2646 the head enters the length 4.5 times. In young specimens, as is usual, the specific characters are not well marked, and the head is one-fourth the length. This peculiarity is retained in a specimen, (No. 14,538) from Saint Thomas, Nev., which is 3 inches in length. An exceptional state of affairs is seen in two large specimens (No. 2651) from the head of the Loup Fork River, Nebraska. The head is one fifth the total length, and the supraorbital crests are parallel, as in typical specimens; but the crests are well separated by a deep gutter behind, whose bottom is not raised above the nape in the usual manner.

Brown above, with pale vertebral line and three pairs of deep-brown medium-sized spots, with paler centers. Sides and lips with small brown spots. Femur and tibia with one indistinct brown cross-bar each. Below uniform yellow. The thoracic region is sometimes black speckled.

This is the Rocky Mountain species, as *B. cognatus* is the species of the plains. Its range does not appear to extend beyond the boundaries of the United States. Its transition to the *B. l. americanus* is easily perceived in seven specimens collected at Pike's Peak by John Yarrow. One of these is a true *B. l. woodhousei*, while the other six can not be separated from the *B. l. americanus*. Dr. Hallowell described a toad under the name of *B. dorsalis* in Sitgreaves' report on the expedition to Zuni and the Colorado River, p. 142, Pl. 19. There is nothing in the description nor in the figure to enable us to ascertain what species or subspecies is represented. The evidence is as much in favor of the specimen having been a *B. l. americanus* as a *B. l. woodhousei*, and no lo-

cality is given to assist in reaching a conclusion. The type specimen can not be found. The name *B. frontosus* Cope applies to this species; a duplication which resulted from the fact that the original specimen is half grown and not typical of the species, and that the original description does not allude to its true characters.

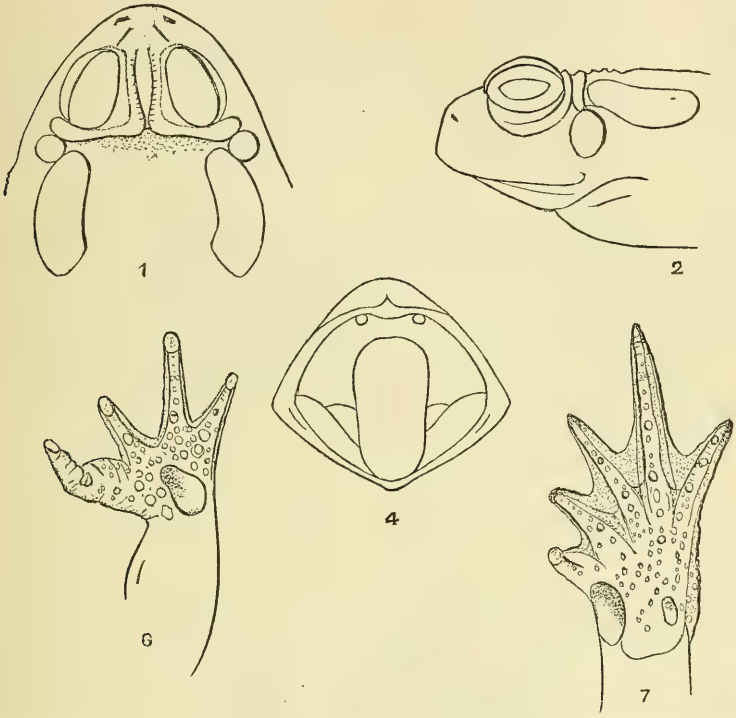


FIG. 69. *Bufo lentiginosus woodhousei.* From Baird, U. S. Mex. Bound. Survey; ½.

Measurements of No. 5243.

	M.
Length of head and body	.098
Width of head at posterior edges of membranum tympani	.035
Length of head to posterior edges of membranum tympani	.020
Length of fore limb	.054
Length of fore-foot	.023
Length of hind limb to groin	.103
Length of tibia	.037
Length of tarsus	.023
Length of remainder of foot	.040

Bufo lentiginosus woodhousei Bd. & Gird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8504	1	Colorado Springs, Colo	July —, 1874	John Yarrow	Alcoholic.
8085	3	Eastern Utah	1872	Dr. H. C. Yarrow	Do.
8164	2	Fairfield, Utah	1871	do	Do.
8505	2	Camp Apache, Ariz	Aug. —, 1873	H. W. Henshaw	Do.
8548	1	do	Aug. —, 1874	J. M. Rutter	Do.
8186	3	Utah	1872	Exped. W. of 100th Mer.	Do.
5068	1	Kansas			Do.
9278	2	Yellowstone River	Sept. 10, 1873		Do.
9713	1	New Mexico	1875	H. W. Henshaw	Do.
10195	1	White River Cañon, Ariz.		Dr. Burr	Do.
2535	2	Yellowstone River		Dr. Hayden	Do.
4185	1	Fort Defiance, N. Mex		H. B. Mollhausen	Do.
5243	3	Cantonment Burgwyn, N. Mex.		Captain Anderson	Do.
4195	1	Platte Valley		Dr. C. Drexler	Do.
2531	1	Calif. Mountains, Mexico		Dr. S. W. Woodhouse	Do.
2646	1	Near Antelope Hills		H. B. Mollhausen	Do.
2632	1	Canadian River		do	Alc. type.
8547	1	New Mexico		Dr. O. Loew	Alcoholic.
14526	1	Fort Custer, Mont	— —, 1885	Capt. Charles Bendire, U. S. A.	Do.
14538	1	Saint Thomas, Nev		Dr. E. Palmer	Do.
2631	2	Swamps on Loup Fork, Nebr.		Dr. Hayden	Do.
7012	1	Athabasca River		R. Kennicott	Do.
4184	2	Upper Colorado region		H. B. Mollhausen	Do.
2552	2	Fort Laramie, Nebr		F. W. Hayden	Do.

Bufo lentiginosus americanus Lec.*

Cope, Check-List N. Amer. Batr. and Reptil., 1875, p. 29; Boulenger, Catal. Batr. Sal. Brit. Mus., 1882, p. 309, fig.

Bufo americanus (Leconte) Holbr., N. A. Herp. v, v. Pl. 4: Dum. & Bibr., p. 695; Hallow., Proceed. Ac. Phila., 1856, p. 251; Girard, U. S. Mex. Bound. Surv., II, p. 25; Wied., Nova Acta, XXXII, p. 121.

Bufo copei Yarrow & Henshaw, Rep. Reptil. Batr., Expl. W. 100th Mer., 1878, p. 4.

Length of head to posterior end of cranial crests entering length to vent four and a half times; cranial ridges narrow, well marked, not uniting in a prefrontal callosity, uniting with the postorbitals at a right angle and projecting but little behind them.

Supratympanic ridge wanting or rarely very short. Preorbital not strong. Parotoids quite elongate, varying a little in breadth. Profile a gradual descent from behind, depressed behind prefrontal bones; muzzle slightly decurved, not projecting; nostril a little nearer orbit than labial margin. Skin everywhere pustular; a few larger warts on each side the vertebral line. Tympanum distinct, half orbit. Middle of fore-arm to muzzle; heel to front of orbit. Metatarsal tubercle prominent, usually narrow; its horny sheath largely blackened; outer tubercle small. No tarsal fold.

Yellowish or darker brown above, with three or four pairs of deeper, small, yellow-edged spots on the dorsal region, separated by a light vertebral line which extends from the end of the muzzle; one or two yellowish streaks extend from the parotoid posteriorly on the sides. The latter and femora behind are finely yellowish marbled on blackish ground. Below dirty yellow; breast frequently black spotted. Length

* Plates 58, 59.

of an average specimen from South Carolina, 2 inches 10 lines; end of muzzle to postorbital ridge, 9.2 lines; of parotoid, 7 lines; fore limb, 1 inch 9.5 lines; hind limb, 3 inches 5 lines; femur one-half included.

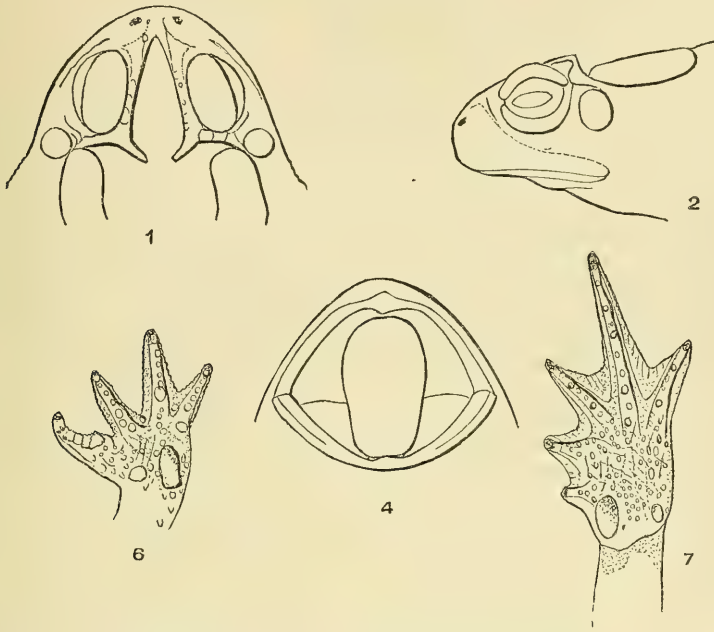


FIG. 70. *Bufo lentiginosus americanus* From Bd. Gird., U. S. Pac. R. R. Surv., vol. x; ¼.

In this, as in other Bufones, the females are larger than the males; and the latter are usually less variegated in colors.

The *B. l. americanus* has been regarded by some authors as a species distinct from the *B. l lentiginosus*; but the examination of a large number of specimens of both shows that all of the distinctive characters are evanescent in some individuals. Thus the superciliary crests rise posteriorly in No. 2497 from Minnesota, so as to approximate the typical Lentiginosus. In some of the specimens of No. 2521, from Charleston, S. C., the extremities of the crests are not more developed than in No. 2534, from the Platte River, Nebraska. The supratympanic crest is represented by an angle of the postorbital in the great majority of specimens, but in seventeen specimens the former is quite as distinct as in numerous specimens of the *B. l. lentiginosus*. These belong to Nos. 2481, 2493, 2472, 2474, 2497, 2557, 5372, and 10066. Nevertheless, it is true that the subspecies *B. l. americanus* maintains its characters entirely within the range of the *B. l. lentiginosus*, as is evidenced by specimens from Prairie Mer Rouge, La. (2557), Milledgeville, Ga. (9430), Monticello, Miss., and elsewhere.

As already described, the parotoid glands of this species are long and rather narrow. A varietal form has them wider and reniform in outline. The five individuals which display this character are from north-

ern localities, viz: No. 2505 from Racine, Wis., and 2507 from Essex County, N. Y. They are also characterized by the presence of a supratympanic crest and by the coarseness of their tuberculation. They have no distinct dorsal spots, a dark line round the bases of some of the tubercles representing them in some individuals.

There are also several color varieties of this subspecies. They are not unfrequently met with entirely black (var. A), as, for example, from Pennsylvania and Michigan. In two or three from the latter region the foot is as short as in short-footed var. woodhousei; in one the superciliary ridges are confluent in a curved transverse ridge. A singular abnormality (No. 2514) (var. B), from Moose River, British America, is distinguished by its yellow, orange, or pinkish ground color, with the dorsal and lateral spots confluent into longitudinal bands more or less broken; warts pink tipped; average size below typical; skin smoother. On this variety was proposed the *Bufo copei* of Yarrow and Henshaw.

Var. C.—A yellow ground with broad brown bands, having only yellow lines running outwardly and posteriorly; on top of these the usual brown spots are well distinguished. The cranial ridges are higher, thicker, and more nearly parallel than usual. Specimens are of large size; they are from South Fork of the Yellowstone, Nebraska. Total length, 4 inches 1 line; length from end of muzzle to postorbital ridge, 11.5 lines.

Habitat.—Southeastern Labrador, *Packard*, Proceed. Bost. Soc. Nat. Hist., 1866; Moose River, British America, *Drexler*; South Fork Yellowstone, *Hayden*; Kansas, *Hallowell*, Proceed. Ac. Nat. Sci., Phila., 1856, 251, and the Eastern and Austroriparian regions of North America generally.

Dwellers in the country are familiar with the voice of this species in the early spring, which is the season of the deposit of eggs. These are laid inclosed in a long, thick-walled tube of transparent albumen, secreted by the walls of the oviducts. These tubes lie in long spiral strings on the bottoms of the ponds where they are deposited. The young hatch out early, and are of a darker color than those of others of our Salientia. They retain the dark color till near the time of the completion of the metamorphosis. This takes place at an earlier date than that of the Ranæ, and the completed young are scarcely as large as those of the Hylæ or of the Scaphiopus. The voice of this species may be heard well into the summer. It is a sonorous ur-r-r-r-r r, which may be readily imitated by whistling while one utters a deep-toned vocal sound expressed in the above letters. Individuals differ in the pitch of their notes, but a chorus of them has a weird sound well befitting the generally remote spots where they congregate, and the darkness of the hour. When not thus engaged, they often take up their abode beneath the doorstep of the farmer's house, and issue in the evening to secure their insect food. They progress by hops, and only walk on very rare occasions.

Bufo lentiginosus americanus Le C.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2482	5	Root River, Wis		Prof. S. F. Baird	Alcoholic.
2505	1	Racine, Wis		Dr. P. R. Hoy	Do.
257	6	Fort Laramie, Wyo		Dr. J. G. Cooper	Do.
2480	4	Salem, N. C		J. T. Lineback	Do.
8342	1	Kinston, N. C			Do.
2479	2	Jackson County, N. C		Fitzgerald	Do.
7843	10	Washington, D. C		Dr. E. Coues, U. S. A	Do.
2515	1	do			Do.
8307	1	do	April 3, 1875	J. Palmer	Do.
2492	1	do			Do.
2470	2	Abbeville, S. C		Dr. J. B. Barratt	Do.
2487	6	Anderson, S. C		Mrs. M. E. Daniels	Do.
2518	1	Charleston, S. C			Do.
2557	7	Prairie Mer Rouge, La		Jas. Fairie	Do.
2554	10	New Orleans, La		N. O. Academy	Do.
2466	3	Framingham, Mass		Prof. S. F. Baird	Do.
2493	3	Union County, Mo		Dr. P. R. Hoy	Do.
2483	1	Missouri			Do.
2521	2	Saint Louis, Mo		Dr. George Englemann	Do.
2476	3	Marietta, Ohio	1853	Prof. E. B. Andrews	Do.
2474	5	Columbus, Ohio		Prof. L. Lesquereux	Do.
2503	1	Highland County, Ohio			Do.
2630	3	Monticello, Miss		Miss Helen Tunison	Do.
2527	1	Mississippi			Do.
2516	3	Mount Holly, N. J		Prof. S. F. Baird	Do.
2555	7	Maryland		Stagg	Do.
2558	2	Fort Smith, Ark		Dr. B. F. Shumard	Do.
2495	1	Tyree Springs, Tenn		Prof. R. Owen	Do.
2463	1	Foxbury, Pa			Do.
2468	1	Philadelphia, Pa		J. H. Richard	Do.
2504	1	do			Do.
2485	50	Carlisle, Pa		Prof. S. F. Baird	Larva.
2498	1	Meadville, Pa		J. F. Thickston	Alcoholic.
2512	1	Carlisle, Pa			Do.
2556	4	Bradford County, Pa		C. C. Martin	Do.
2653	1	South Platte			Do.
2507	10	Essex County, N. Y		Prof. S. F. Baird	Do.
2494	3	Oneida County, N. Y		H. Davis	Do.
4782	1	Elizabethtown, N. Y			Do.
2481	5	Aux Plains, Ill		R. Kennicott	Do.
	2	Southern Illinois		do	Do.
2496		Western Mississippi			Do.
2497	3	Minnesota		A. L. Riggs	Do.
5372	6	South of Highlands		C. Drexler	Do.
8503	1	Plaza del Alcaide, N. M		Dr. H. C. Yarrow	Do.
2533	1	Little Blue River, Kans		W. S. Wood	Do.
2510	3	Eutaw, Ala		Prof. A. Winchell	Do.
2534	1	South Platte River, Nebr	July 14, 1856	W. S. Wood	Do.
9130	3	Milledgeville, Ga	June 4, 1876	Kumlien & Bean	Do.
2486	200	Carlisle, Pa		Prof. S. F. Baird	Larva.
2552	1	Fort Laramie, Nebr			Alcoholic.
9425	1	Eastport, Me	1872	U. S. F. C	Larva.
2472	1	Russellville, Ky		George Bibb	Do.
4916	1	Pearl River, Miss		Miss H. Tunnison	Do.
4861	6	Nebraska		Dr. George Suckley, U. S. A	Do.
9473	1	do			Do.
8971	1	Wood's Holl, Mass		Dr. T. H. Bean	Do.
9286	4	Havre de Grace, Md	June 14, 1876	A. L. Kumlien	Alcoholic.
9298	2	Norfolk, Conn	Sept. 26, 1877	A. F. Wooster	Do.
8655	1	Utah	1872	Dr. H. C. Yarrow	Type.

GENERAL SERIES.

2549	11	South Platte		Dr. W. A. Hammond, U. S. A	Alcoholic.
2502	7	Washington Co., Miss		Col. B. L. C. Wailes	Do.
9474	2	(?)			Do.
9437	8	(?)			Do.
9154	1	Fort Mohave, Ariz	April 15, 1862	Dr. J. G. Cooper	Do.
9433	1	(?)			Do.
9434	1	(?)			Do.
9435	1	Camak, Ga	1876		Do.
9436	1	Central Park			Do.
9506	3	(?)			Do.
2538	1	Platte River	July 1, 1857	W. S. Wood	Do.
2549	2	South Platte River		Dr. W. A. Hammond, U. S. A	Do

Bufo lentiginosus americanus Le C.—Continued.

GENERAL SERIES—Continued.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2537	51	Mississippi River		Col. J. H. Vaughan	Alcoholic.
2477	2	Danvers, Mass		Prof. S. F. Baird	Do.
3700	1	Center County, Pa		Brugger	Do.
4101	5	Yellowstone		A. Schott	Do.
4543	4	Fort Riley, Kans		H. Brandt	Do.
4370	7	New Orleans, La			Do.
8955	1	Kinston, N. C		J. W. Milner	Do.
8340	1	Goldsborough, N. C		H. W. Welsher	Do.
9314	7	Platte Valley		Dr. W. A. Hammond, U. S. A	Do.
8341	6	Kinston, N. C		J. W. Milner	Do.
2507	8	Essex County, N. Y		Prof. S. W. Baird	Do.
13847	1	Hudson's Bay	1884.	F. Walton Haydon	Do.
11485	8	Washington, D. C		Dr. T. H. Bean	Do.
11948	1	Wheatland, Ind	1881.	Robert Ridgway	Do.
10066	1	Saint James Parish, La	1879.	O. de la Peichardière	Do.
14519	1	Gainesville, Tex	1885.	G. H. Ragsdale	Do.
14520	1	do	1885.	do	Do.
5367	7	Moose River, Brit. Am		C. Drexler	Do.
2489	2	Southern Illinois		R. Kennicott	Do.
11952	2	Southampton County, Va	1874.	L. Kumlien	Do.
8504	7	Colorado Springs, Col	1874.	John Yarrow	Do.
14175	1	Olney, Ill	1885.	John and Charles Walker	Do.
13327	1	District of Columbia		George Shoemaker	Do.
11530	1	Chula, Va	1879.	F. H. Cushing	Do.
2515	1	Washington, D. C		S. F. Baird	Do.
11077	6	(?)		(?)	Do.
4541	1	Grand Coteau, La		(?)	Do.
11506	1	California	1877.	L. Kumlien	Do.
2506	2	Saint Louis, Mo		George Engelmann	Do.
2527	1	Mississippi		D. C. Lloyd	Do.
2504	2	Philadelphia, Pa		J. Richard	Do.
4842	1	Brookville, Ga		R. Haymond	Do.
1148	1	Pensacola, Fla		Jeffries	Do.

A well-marked variety of this subspecies, or perhaps a distinct subspecies, is represented by two specimens from Micanopy, Fla., which were obtained by Dr. Bean. The distinguishing peculiarity consists in the conversion of the superciliary ridges into flattened thickenings of the cranium, which meet or nearly meet on the middle line of the fronto-parietal region. They unite, leaving a faint line to mark the junction in the larger female, while in the smaller male they form two beveled surfaces, which unite on the middle line at an obtuse angle. Posteriorly they, with the postorbital ridges, have a straight transverse boundary. The metatarsal internal digital spur is as well developed as in many of the typical specimens, but the plantar tubercle is small. The web of the foot is well developed, reaching the end of the first (proximal) phalange. It only reaches to the middle of the proximal phalange in the *B. l. americanus*. The color is somewhat peculiar, having a general clouded appearance above, without the well-defined spots of the typical subspecies Americanus. There is a pale band from one palpebral border to the other across the front. The median dorsal line is indistinct. Size that of fully grown *B. l. americanus*. This form may be called *Bufo lentiginosus pachycephalus*.

Bufo lentiginosus lentiginosus Shaw.

Cope, Check-List N. Amer. Batr. Reptil., 1875, p. 29.

Bufo lentiginosus Shaw, Zoöl., III, p. 173, 1803; Girard, Proceed. Ac. Phila., 1854, p. 86.
Chilophryne lentiginosa Cope, Proceed. Ac. Phila., 1863, p. 357.
Bufo musicus Latr, Rept., II, p. 127; Daud., Rain., p. 9, Pl. 33, fig. 3, and Reptil., VIII, p. 190; Merr. Tent., p. 185; Gravenh., Delic., p. 59, Holbrook, N. Amer. Herpét. V, Pl. 1; Dum. Bibr. Erp. Gen. VIII, p. 689; Leconte, Proceeds. Acad., Philada., 1863, p. 357.

Head large; snout obtuse; superciliary ridges greatly elevated and terminating posteriorly in a knob; upper jaw emarginate, lower furnished with a hook in front; parotoid large, reniform, and reaching from below the tympanum to near the shoulder; tympanum large; vocal vesicle internal; body above warty, beneath granulated.

The head is large, and without warts, except a few small ones on the eyelids, and the mouth is large. The snout is obtuse, and from its tip runs an elevated bony crest, subdividing at the nostrils, and forming the superciliary ridges. These diverge and increase in elevation as they reach the posterior part of the orbit, where they terminate in a rounded knob or tubercle. Their greatest height gives to the upper surface of the head a canaliculated appearance; a second or postorbital ridge descends from each of these and completes the posterior border of the orbit. In consequence of the divergence of the superciliary ridges the postorbitals are short. There is always present a short but distinct ridge above the tympanum at right angles to the postorbital—the supratympanic. The upper jaw is deeply emarginate in front; the lower is furnished at its anterior part with a distinct hook, which is received in the notch of the upper jaw.

The nostrils are small and round, placed near the point of the snout. The eyes are large, prominent, and very beautiful; the pupil is black, the iris reticulated with gold and black, and has an inner margin of yellow. The tympanum is large and dusky, with a minute spot of a lighter shade in the center. The parotoid glands are large and reniform.

The back and sides are dusky, and covered with warts of different sizes; a pale vertebral line extends from the head to the vent, on each side of which are found the largest warts; an irregular row of spots of yellowish-white exists on the flank, having somewhat the appearance of an indistinct band, extending from the inferior and posterior part of the parotoid gland to within a short distance of the thighs. The whole inferior surface of the animal is dirty white, with a strong tinge of yellow.

The anterior extremities have the upper surface dusky, with blotches and bars of dark brown; the lower surface dirty white, tinged with yellow. The posterior extremities are dusky brown above, marked with blotches and transverse bars of darker brown, and dingy white beneath.

This species attains to the same size as the typical form of *B. l. americanus*. A specimen (4501) from Florida exhibits remarkably elevated

crests and broad parotoid glands; the coloration is uniform cinnamon-brown; apparently a slight variety.

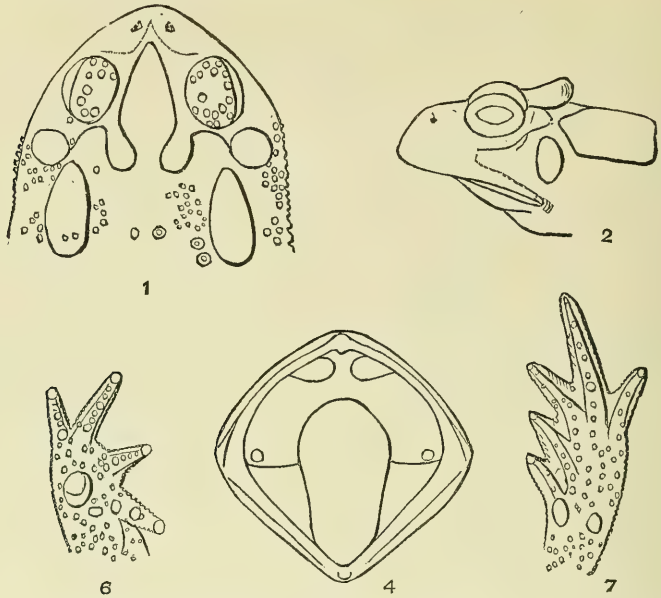


FIG. 71.—*Bufo lentiginosus lentignosus*; ½. (From Baird & Girard.)

Besides the presence of tuberosities of the frontoparietal crests and of a supratympanic crest, this subspecies is well marked by the relatively elongated head. It enters the length to the vent three and a half times in typical examples. In some specimens it enters the length 3.75 times, and in others four times, quite as in *B. l. americanus*.

The *B. l. lentiginosus* is confined to the austroriparian region east of Texas, and all statements to the contrary are based on error. It does not ascend the Mississippi Valley, so far as is known.

Bufo lentiginosus lentiginosus Shaw.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2525	10	Riceborough, Ga		Prof. S. F. Baird	Alcoholic.
5902	1	Shelby County, Ga		Maj. J. Le Conte	Do.
2520	8	Pensacola, Fla		Dr. W. A. Hammond, U. S. A.	Do.
2526	1	Indian River, Florida		G. Wurdemann	Do.
2519	1	Georgetown, S. C		Weston	Do.
8902	3	Lake Monroe, Florida	Apr. —, 1877	Prof. S. F. Baird	Do.
3383	2	Charleston, S. C			Do.
2521	8	do		Dr. C. Girard	Do.
2522	2	Alabama	1853	Prof. A. Winchell	Do.
2553	9	Liberty County, Ga		Dr. W. L. Jones	Do.
9426	2	Beaufort, S. C			Do.
9952	2	Little Sarasota Bay, Fla	1875	Prof. F. B. Meek	Do.
9705	1	Arlington, Fla	1878	G. Brown Goode	Do.
2528	4	Anderson, S. C		Miss C. Paine	Do.
2527	3	Mississippi		D. C. Lloyd	Do.
9472	1	(?)	July —, 1875	P. L. Jouy	Do.
745	11	Micanopy, Fla		Dr. J. H. Bean	Do.
9438	2	(?)			Do.
3383	15	Charleston			Do.
11502	1	Nashville, Ga	1880	William J. Taylor	Do.
11397	10	Milton, Fla	1881	S. T. Walker	Do.
11915	1	Nashville, Ga	1830	William J. Taylor	Do.

BUFO QUERCICUS Holbrook.

North Amer. Herp., v, 13, 1846, Tab. III; Cope, Proceeds. Amer. Philosoph. Soc. 1886, p. 515.

Chilophryne dialopha Cope, Proceed. Ac. Nat. Sci. Phila., 1862, 341 (erroneous locality). *Bufo dialophus* Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882, p. 319.

Head broad; muzzle prominent, conic. Cranium strongly ridged. Preocular and postocular, supratympanic, and superciliary ridges well developed, the last making a very open angle with that of the canthus rostralis, and sending off posteriorly a parietal, which first converges toward that opposite, and then runs transversely on the occiput to meet it, failing in this by a very slight interval. A small nuchal pit. Tympanum in contact with postorbital ridge, only one-fourth the size of the orbit. Tongue small, narrow, half free; a strong symphyseal tubercle fitting a premaxillary pit. Parotoids large, short, descending on sides to opposite lower edge of tympanum. Skin everywhere rigidly rugose, subspinous on the tarsus. The joints of the extremities are pale and appear swollen. Fingers slender; first shorter than second, which equals the third. One metacarpal tubercle only. Toes short, one third webbed; two acute metatarsal tubercles, the internal large, incurved, like a flattened spur, yellow, brown tipped. Length of head and body, 10 lines; of hinder extremity, 12 lines.

The head above is dusky, with a yellowish central longitudinal line; the superciliary ridges are gray, with a white mark in the center. On each side of this longitudinal line is an oblong black spot, extending from it to include most of the posterior part of the orbit of the eye; a small part only of the orbit in front of this is light colored; the upper jaw is light brown.

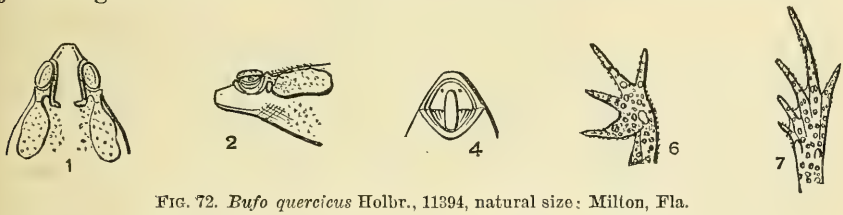


FIG. 72. *Bufo quercicus* Holbr., 11394, natural size: Milton, Fla.

The back of the animal is dusky brown, with a vertebral line of pale yellow, marked with a few scattered small warts of reddish-brown color. On each side of this line are irregular black blotches, with here and there a slight tinge of reddish-brown. The back is covered with innumerable warts and granulations of variable size and color, generally black, but the smaller ones of dusky red. On each flank, and extending from the axilla downwards toward the posterior extremity, is an oblong black blotch bounded with white both above and below.

The throat is dusky; the abdomen silvery-gray, yellowish at the groin, and with a pale tinge of yellow around the vent. The anterior extremities, as well as the posterior, are dusky brown above, marked with black transverse bars or spots. Their inferior surface is colored like the abdomen, except the fingers and toes, which are reddish-brown,

This is the smallest known species of the genus Bufo. The measurements of an adult are as follows:

	M.
Length of head and body	.027
Length of head to posterior edges of tympana	.007
Width of head at posterior edges of tympana	.0086
Length of anterior leg	.0146
Length of anterior foot	.006
Length of posterior leg from groin	.0237
Length of tibia	.0086
Length of tarsus	.005
Length of rest of foot	.0085

In some specimens the transverse posterior part of the frontoparietal crest is broken up. It then resembles the young of the *Bufo lentiginosus*, with which it has been supposed to be identical by various authors. It, however, differs from this species in the differently shaped parotoid glands, the thickened posterior parts of the mandibles, and from all the subspecies, except the *B. l. woodhousei*, in the shorter head. There is no doubt but that Dr. Holbrook was correct in regarding this as a distinct species of very small size. The redescription of the species by myself was due to the omission of its characteristic peculiarities from extant writings. The erroneous locality (Sandwich Islands) is one of several such errors, based on the incorrect labeling of the collections of J. H. Townsend, to which the specimen belonged.

The geographical distribution of this species is restricted to the region extending from Kinston, N. C., to Middle Georgia and Florida, inclusive.

Bufo quercicus Holbrook.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
5911	5	Georgia		Maj. J. Le Conte	Alcoholic.
8343	1	Kinston, N. C		J. W. Milner	Do.
9695	1	Arlington, Fla	May 1, 1878	G. Brown Goode	Do.
9945	4	Little Sarasota Bay, Fla.	1875	Prof. F. B. Meek	Do.
2626	3	Georgia	1855	Maj. J. Le Conte	Do.
2625	3	Charleston, S. C		Dr. S. B. Barker	Do.
11394	2	Milton, Fla	1881	S. T. Walker	Do.

BUFO VALLICEPS Wiegm.

Bufo valliceps Wiegm., Isis, 1833, p. 657; Peters, Mon. Berl. Ac., 1863, p. 81; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., p. 319.

Bufo granulosus Baird & Girard, Proceed. Ac. Phila., 1852, p. 173.

Bufo nebulifer Girard, Proceed. Ac. Phila., 1854, p. 87; Hallow., *Ibid.*, 1856, p. 308; Girard, U. S. Mex. Bound. Surv., II, p. 25, Pl. 40, fig. 1–4; Günth., Cat. Brit. Mus., p. 66.

Chilophryne nebulifera Cope, Proceed. Ac. Phila., 1862, p. 357.

Postorbital ridge forming an open angle with the supraorbital; preorbital distinct; supraorbital strong, nearly plane, $1\frac{3}{4}$ the strong supra-

tympanic. Ridges of canthus concave, parallel on end of muzzle; latter truncate in profile. Strong maxillary ridge from inferior margin of orbit to posterior extremity of the bone. Loreal region concave, nostrils subvertical; tympanum half orbit. Two strong convergent parietal ridges from supraorbital, each longer than supratympanic of its side. Length of head from end muzzle to posterior border tympanum equals breadth below at canthus oris in specimens 1.5 inches long; relatively less in larger specimens, till in one 3.75 inches long it is scarcely over two thirds the breadth. Eyelids nearly horizontal; tongue ordinary obpyriform; choanæ larger than ostia pharyngea. Length of head, as above, three to three and a quarter times from end of muzzle to end of urostyle. Parotoid glands measured longitudinally equal supraorbital ridge, longer obliquely; acuminate posteriorly and continuous with a lateral series of acute tubercles (sometimes on a plica), which extend downwards to groin. Skin above with scattered rounded, on sides with close acuminate, tubercles; below with close small rounded tubercles.

Second finger short—less than fourth; a keeled palmar and elongate pollicary tubercle; palms and soles rough with tubercles. A small acuminate and insignificant external metatarsal tubercle. No inner tarsal fold. Toes half webbed and margined. The carpus of the extended arm reaches beyond the muzzle; the heel attains from the hinder to the front margin of the orbit.

Dimensions of an adult (San Antonio): From end muzzle to end urostyle, 3 inches 9 lines; from same to posterior margin tympanum (oblique), 2 inches 25 lines; anterior extremity, 1 inch 4.5 lines to carpus + 8 lines to end longest finger; femur, 1 inch 6 lines; tibia, 1 inch 3 lines; foot from heel, 2 inches; tarsus, 10 lines.

Coloration: Above a chestnut-brown, with a dark cross-band between orbits. A dark lateral band from behind orbit along the side to groin, following below the lateral fold, which is light-bordered above; a more or less distinct light vertebral line; upper lip yellow-bordered. Breast and gular regions more or less slate-shaded. Limbs brown, cross-barred.

Varieties: Of these I am acquainted with three, which are quite distinguishable. First. The typical has a strong parietal ridge, is scarcely varied with darker below, and is light brown above; sides very tuberculous; specimens from Texas, Tamaulipas, and Vera Cruz—Emory and Sartorius. Second. Sides with smaller granulations; colors blackish, spotting and varying the whole inferior regions. Three specimens from Yucatan (Nos. 729, 778, 779)—Schott. Third. Ridges weaker, especially the parietal; cinnamon-brown, below brown varied and spotted; sides granular. Two specimens from Belize—Dr. Parsons.

Specimens in National Museum from the United States:

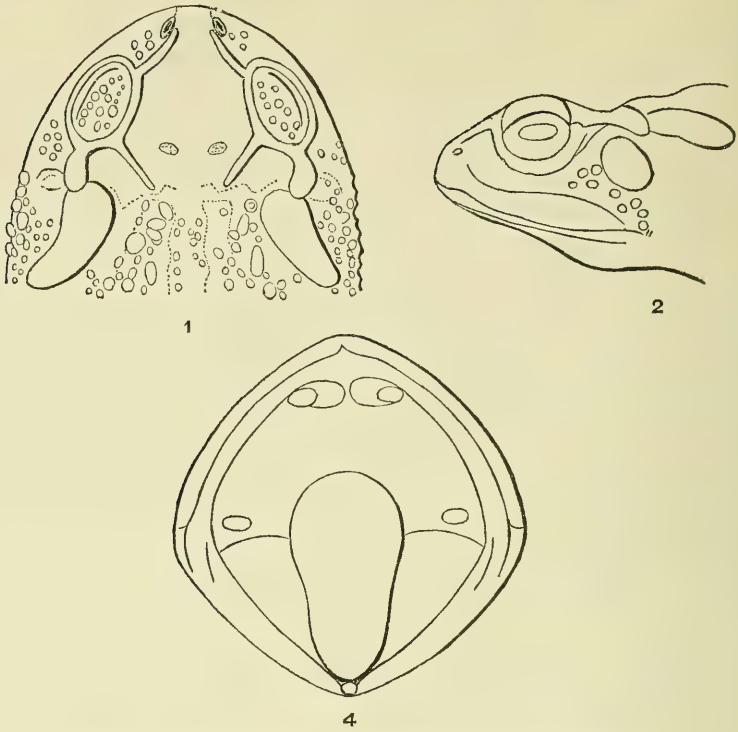


FIG. 73. *Bufo valliceps* Wieg. (From Baird, U. S. Mex. Bound. Surv.)

Bufo valliceps Wiegmann.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
2663	10	Calcasieu Pass, La		G. Wurdemann	Alcoholic.
2605	7				Do.
2595	1	Texas		J. H. Clark	Do.
2598	1	Brownsville, Tex		Prof. S. F. Baird	Do.
2594	1	Fort Inge, Tex		Dr. C. B. R. Kennerly	Do.
2602	2	New Braunfels, Tex		Prof. S. F. Baird	Do.
2399	2	Santa Caterina, Nuevo Leon.		Lieut. B. Couch, U. S. A.	Do.
2592	1	San Pedro, Tex		Dr. C. B. R. Kennerly	Do.
2591	2	Matamoros, Mex		Lieut. B. Couch, U. S. A.	Do.
2600	2	Between Laredo and Camargo.		A. Schott	Do.
2601	1	San Antonio, Tex		C. B. R. Kennerly	Do.
1150	3	(?)		(?)	Do.
		New Orleans, La		Dr. R. W. Schufeldt	Do.

This species is also common in Louisiana, numerous specimens having been sent from New Orleans by Dr. Shufeldt, and by Prof. Pen. King from Baton Rouge. Its southern range extends as far as Nicaragua, inclusive.

DENDROPHRYNISCIDÆ.

This family is said by Boulenger to differ from the Cystignathidæ, only in the absence of the premaxillary and maxillary teeth.

There are but two genera, as follows:

No vomerine teeth. Tongue entirely adherent; no tympanum nor Eustachian tubes; toes webbed, external metatarsals united; omosternum and sternum cartilaginous; terminal phalanges simple ..... *Batrachophrynus* Peters.

No vomerine teeth; tongue free posteriorly; fingers and toes slightly webbed; the tips dilated; no omosternum; sternum with osseous style.

Dendrophryniscus Espada.

There are but two species of Batrachophrynus, which are from Peru. The single species of Dendrophryniscus was found near Rio de Janeiro.

ASTEROPHRYDIDÆ.*

Vertebræ opisthocœlous. Diapophysis of sacrum dilated, of urostyle wanting; the latter attached by but one cotyloid cavity (except in one genus). Ribs none. Sternum undivided.

In the known genera the external metatarsi not separated for a web; terminal phalanges continuous, simple. O. frontoparietalia not strongly ossified medially, but without fontanelle. Superior plate of the ethmoid well developed anteriorly. Ear perfectly developed.

Genera: Cryptotis, Gthr.; Asterophrys, Tsch.; Megalophrys, Kuhl.

The Palæobatrachidæ differ from this family in the conversion of their seventh, eighth, and ninth vertebral centra and diapophyses into a sacrum, instead of the ninth only. The supposed osseous covering of the cavum tympani and tuba Eustachii, is not confirmed by the researches of Walterstorff.

Cryptotis, the only Australian genus of the family, possesses two sacral condyles for the articulation of the coccyx; it has a long tooth, like process on the os dentale, similar to that seen in *Rana macrodon* and *R. kuhlii.*

The other genera belong to the Malayan Islands. There are no arboreal or aquatic forms embraced in this family. The whole number of species known is five.

a. Toes free.

Two postsacral condyles; o. dentale with a dentiform process; vomerine teeth; no parotoids; sternum a cartilaginous plate†. ..... *Cryptotis.*

One postsacral condyle. No dentiform process. Head large, angular; upper palpebral border with cutaneous appendages. Vomerine teeth. Tongue entirely adherent. Tympanum hidden, perfect. ..... *Asterophrys.*

aa. Toes partially webbed.

One postsacral condyle; vomerine teeth little developed; sternum with a bony style; tongue broad, free behind (tympanum concealed) ..... *Megalophrys.*

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* Plate 68. † Teste Boulenger.

PELODYTIDÆ.*

Vertebræ procœlous; no ribs or diapophyses of coccyx. Sacrum united with the coccyx by condyle, its diapophyses dilated.

The species of this family are of weak organization; the frontoparietal bones are undeveloped in one of the four genera embraced by it, and they are very weak in the others. Their affinities are altogether between the Asterophrydidæ and Scaphiopodidæ. Their vertebræ only distinguish them from the former and their distinct bicondyloid coccyx from the latter. In the known genera the auditory apparatus is developed, and the cephalic integument is free; in none is there a metatarsal shovel.

a. Sternum with an osseous style.

No dentary apophysis; no vomerine teeth; tongue broad, but little free; tympanum distinct; one postsacral condyle ..... *Xenophrys.*

Frontoparietal bones complete; no vomerine teeth; one sacral condyle for urostyle; tongue partially free ..... *Leptobrachium.*

Frontoparietal bones embracing a large fontanelle; vomerine teeth; two sacral condyles for the coccyx; a weak parotoid gland; pupil elliptic, erect; tongue partially free; atlas and axis confluent ..... *Pelodytes.*

aa. Sternum without osseous style.

Frontoparietal bones complete; vomerine teeth; two postsacral condyles. *Batrachopsis.*

In the species of Leptobrachium and Pelodytes the external metatarsi are bound together; in the only known species of Batrachopsis they are, according to Boulenger, slightly separated.

This family has a peculiar distribution. Pelodytes is European, Xenophrys and Leptobrachium are Palæotropical, and Batrachopsis, Australian (New Guinea).

SCAPHIOPIDÆ.*

Cope, Journ. Ac. Phila., 1866, p. 69; Nat. Hist. Rev., 1865, p. 11, pars.

Pelobatidæ Lataste, Actes Soc. Linn., Bordeaux, xxx, 339, pars; Boulenger Catal. Batr. Sal. Brit. Mus. Ed. ii, 1882, p. 432, pars.

Vertebræ procœlian; no costal elements or coccygeal diapophyses; diapophyses of ninth vertebra much dilated, thin, and triangular; urostyle without condyloid articulation, its axial portion restricting that of the sacrum and connate with it: external metatarsi bound; distal phalanges continuous, simple. Manubrium cartilaginous. Tongue rounded, nearly entire.

The small number of species embraced in this family are of stout toad-like habit, and furnished with a shovel-like development of the cuneiform bone and a coriaceous posterior digital palmation, to aid them in removing earth while making their subterranean abodes. Many of them very seldom come to the surface of the earth, and then only in darkness; for this habit the vertical cat-like pupil is an adaptation, a peculiarity not exhibited by the toads, which are crepuscular.

* Plate 68.

I. Cavum tympani and tympanum wanting. Xiphisternum with an ossified proximal style. Cuneiform bone and sheath well developed. Pupil erect. Toes webbed.

Derm involved in cranial ossification. Temporal fossa with a strong roof. Vomerine teeth: no parotoid glands ..... *Cultripes.*

Derm involved in cranial ossification. No roof over the temporal fossa, or parotoid glands. Vomerine teeth ..... *Pelobates.*

Derm distinct from cranium, which is undeveloped above, two lateral frontoparietal bars inclosing a median fontanelle. Vomerine teeth. No parotoids ..... *Didocus.*

Cuneiform bone and sheath well developed. Toes more or less webbed.

II. Cavum tympani and tympanum present. Xiphisternum entirely cartilaginous. Pupil elliptic erect.

Derm involved in the cephalic ossification, which is complete. Parotoid glands and vomerine teeth ..... *Scaphiopus.*

Derm distinct from cranium, which is usually only ossified superiorly in two superciliary bars. Parotoid glands and vomerine teeth ..... *Spea.*

The extreme of divergence of the series of this family is, then, that representing its type in a pre-eminent degree. This is seen in the genus Cultripes where the ossification of the superior cranial walls is especially thickened, obliterates the sagittal suture, and is extended in an arch over the temporal fossa. The anterior ossification of the coccyx is applied by its axial portion beneath the axis or centrum of the sacral vertebra, and becomes consolidated with it shortly after its commencement, furnishing a structure not rare among burrowing Anura. This character is maintained in the descending scale by Pelobates, Didocus, Scaphiopus, and Spea, though none of these have the temporal fossa overarched. Cultripes, with Pelobates and Didocus, exhibit an ossified basal xiphisternal piece, while in all below it is cartilaginous, as in most Arcifera; the extreme position of the former is also maintained by the obliteration of many portions of the auditory apparatus. The succeeding forms—Scaphiopus and Spea—resemble the first group in the toad-like form and in the strong cuneiform shovel and webbed feet.

The distribution of the species of the family is as follows:

	R. Neotrop.	R. Nearctica.	R. Palæarct.
Cultripes	0	0	(?) 1
Pelobates	0	0	1
Didocus	0	0	1
Scaphiopus	0	2	0
Spea	0	2	0
	0	4	3

The inferior dermal attachments of seven species of this family are as follows:

Didocus calcaratus. Belly more than half attached.

Pelobates fuscus. From half to two-thirds attached; same in larva, with long tail; femur one line below.

Scaphiopus holbrookii. Free only opposite sternum; thigh attached only below on basal half.

Scaphiopus couchii. Triangular free area to middle abdomen.

Spea hammondii. Very wide lateral inferior attachments, which do not meet till femora.

Spea bombifrons. Belly with a free median band; femoral lines below and above behind.

Spea multiplicata. A free dorsal line, very narrow in front, but wide as ilia behind; abdominal area with a broader free space.

SCAPHIOPUS Holbrook.

N. Amer. Herp., II, p. 85; Tschudi, Batr., p. 83; Dum. & Bibr, VIII, p. 471; Günth., Cat., p. 38; Cope., Nat. Hist. Rev., 1865, p. 108, and Journ. Ac. Phila. (2), VI, p. 81; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 433.

Cavum tympani and tympanic membrane present; sternum a cartilaginous plate; pupil erect; toes webbed; internal cuneiform bone of tarsus well developed.

This genus embraces species of robust form and of burrowing habits. The greater part of their lives is spent beneath the surface of the ground, but in spring they emerge and proceed to deposit their eggs in the nearest body of water. This is usually of a temporary character, and in adaptation to this circumstance the metamorphosis is correspondingly rapid. They are very irregular as to the period of its completion, in dry regions losing their larval appendages while very small, while in other and well-watered regions they retain them until fully grown. During the season of reproduction they are very noisy, but after that time disappear, and are neither seen nor heard. They are of plain colors. Their general forms are like those of their allies of the Old World, the species of Pelobates, or somewhat like that of toads.

There are two well-marked species of this genus, which differ as follows:

α. Collections of glandular crypts on the post-tympanic and pectoral regions. Front wide; interorbital width entering length of tibia 2.5 times; vomerine teeth a little behind choanæ; color dark, with or without two pale longitudinal stripes ..... *S. holbrookii.*

αα. No glandular enlargements on post-tympanic or pectoral regions. Front wide; interorbital width entering length of tibia three times; vomerine teeth a little behind nares; color light, with a net-work of brown bands ..... *S. couchii.*

SCAPHIOPUS HOLBROOKII Harlan.

(Plates 57, fig. 2; 68, fig. 3; 73, fig. 30.)

Baird, Report U. S. Pac. R. R. Surv., IV, Reptil., 1859, Pl. XXVII, fig. 1. 1; Cope, Proceed. Ac. Phila., 1863, p. 54.

Rana holbrookii Harlan, Med. Phys. Researches, 1835, p. 105.

Scaphiopus solitarius Holbrook, N. Am. Herp., 1836, Vol. I, p. 85, Pl. XII, *ibid.* (edit. alt.), 1842, IV, 109, Pl. XXVII; Tschudi, Mém. Neuchatel, I, 1838, p. 83; Dum. & Bibr., Erp. Gén., 1841, VIII, 473; Le Conte, Proceed. Ac. Nat. Sci. Phila., 1855, 429; Günth., Cat. Batr. Sal. Brit. Mus., 1858, p. 38; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 434.

Head large; maxillary outline rounded. Profile of front a rather steep descent from the swollen occiput, where the skin is thin, closely adherent, and penetrated by osseous granules. Eyes prominent. Tympanum distinct, half its extent larger than ostia pharyngea. Vomerine teeth in two fasiculi between and behind the posterior borders of the latter. Parotoids small, rounded, prominent. No gland on the tibia; one on each side of the thorax near the axilla. Skin of back minutely tuberculous, of sides more coarsely; below nearly smooth. Cuneiform process longer than in any other species of the genus, but not more prominent. Heel of extended hind leg reaching posterior edge of tympanum.

The inner nostrils are large, open, rather elongated transversely, and wider apart than are the external nares. The vomerine teeth are in two patches, situated within the inner nares, and on a line with their posterior borders. The teeth in the margin of the jaw are continuous, though not much developed. The tongue is longitudinally oval, not emarginate behind in the specimen examined, where it is free for nearly half its length.

The skin above and on the sides is covered pretty uniformly with tubercles or pustules, with smaller hard black ones interspersed. The first mentioned are wanting on the head and outer surfaces of the limbs, where the others, however, may be observed. A few pustules about the anus on the buttocks which show little signs of granulation. There is a short parotid gland just above and behind the tympanum.

The arm is well developed; the hand much shorter than the fore-arm. The outer finger is very short; then the second; the fourth is a little shorter than the third, or longest. All are subtruncate, or thickened at the tips. A thickened web may be traced between the bases of the fingers, although such palmation is not very evident. On the inner and upper faces of the two inner fingers is a black, callous thickening of the epidermis. The tibia is much shorter than the femur, and not one-third the total length of body; the foot and femur about equal. The metatarsal bones are firmly united nearly to the end by intermediate muscle, and a web extends between the tips of the short toes. The outer toe is very short, but little exceeding the third, and the web between it and the fourth toe is proportionally reduced.

All the toes are much depressed, and invested by the thickened skin. At the base of the inner toe is an elongated, compressed, and well-developed spade like process, with a sharp horny edge, of a black color; a trace of the same is seen on the inner edge of the tip of the inner toe. The sole is perfectly smooth, and there is no tubercle of any kind except the spade-like process.

Color above, in spirits, either earth-brown, fulvous-brown, or ashy-brown, with a pale ashy band from each orbit; these converge again on the coccyx. These bands are rarely unbroken, and are sometimes exceedingly indistinct; they sometimes inclose a pale area. Sides

sometimes marbled with pale ash, sometimes uniform. Sometimes a pale interorbital cross-band, sometimes two longitudinal bands on muzzle. A vertical light line on end of muzzle.

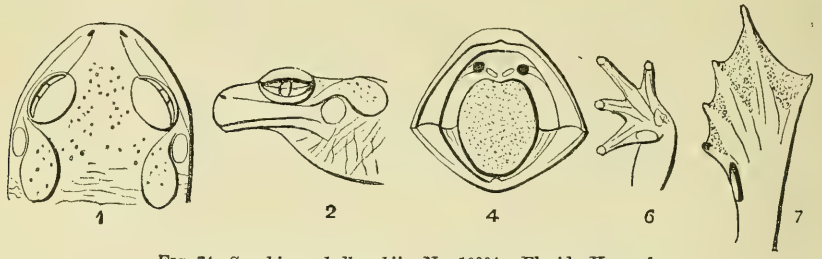

FIG. 74. *Scaphiopus holbrookii*. No. 10004. Florida Keys; ½.

Measurements of No. 11894.

	M.
Length of head and body	.068
Length of head, including tympana	.023
Width of head, including tympana	.0275
Length of fore-leg from axilla	.035
Length of hind leg from groin	.076
Length of tibia	.0217
Length of tarsus	.012
Length of rest of foot	.027

The wide front and peculiar glands of this species readily distinguish them from all others members of the genus. Its range, like that of so many other North American Batrachia and reptiles, is confined to the eastern region. It is found in every part of this, including the Floridan and Texan districts.

Scaphiopus holbrookii Harlan.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
9390	2	Liberty County, Ga		Maj. J. Le Conte	Alcoholic.
9709	8	Milledgeville, Ga	1876	Kumlien & Bean	Do.
3710	1	Cambridge, Mass			Do.
3696	2	do		J. H. Richard	Do.
4559	1	Pearl River, Miss		Miss Helen Tunison	Do.
3706	1	Indian River, Fla		G. Wurdemann	Do.
3712	1	do		Prof. L. Agassiz	Do.
4563	1	Saint Simon's Isle, Ga		J. B. Postell	Do.

Specimens from Cambridge, Mass., are nearly unicolor, while Floridan forms are lightest and most variegated; the head seems to be a little broader and more obtuse. These forms graduate into the intermediate and most common type. Mr. C. W. Hargitt (see American Naturalist, June, 1888) has found it on the Island of Martha' Vineyard, a fact which indicates the comparatively late separation of that island from the main land of Massachusetts.

Habits.—This species, though so widely distributed, is seldom seen. After rains in spring and summer its cries may be heard at night, proceeding always, so far as my experience goes, from temporary pools. I have observed it twice in Pennsylvania, twice in New Jersey, and once in Massachusetts on the main land opposite Martha's Vineyard. Specimens from the latter locality which I kept in a vivarium buried themselves in the earth by day, but issued at nightfall and industriously explored their surroundings. Their burrows were concealed by the loose earth which fell into and filled them, but below this the bony top of the head could be always found. Frequently one eye projected from the débris, presenting with its brassy-colored iris a most singular appearance. On being irritated with a hard object they utter a clattering note entirely unlike that of the breeding season.

SCAPHIOPUS COUCHII Baird.

(Plate 68, fig. 2.)

Proceed. Ac. Phila., VII, 1855, p. 62, and U. S. Mex. Bound. Surv., II, 1859, Rept., p. 28, Pl. 35, figs. 1–6; Cope, Proceed. Ac. Phila., 1863, p. 52; Brocchi, Miss. Sc. Mex., Batr., p. 26; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 454.

Scaphiopus varius Cope, *l. c.*, p. 52; Brocchi, *l. c.*, p. 27.

Scaphiopus rectifrenis Cope, Proceed. Ac. Phila., 1863, p. 53; Brocchi, Miss. Sc. Mex., Batr., p. 27; Boulenger, Cat. Brit. Mus., 2d ed., 1882, 435.

Form stout; head more elongate, acuminate oval; width of frontal region greater than from lip to nares, one-third the length of the tibia. Profile gradually descending; front plane, muzzle projecting, rounded. Anterior border of tympanum scarcely distinguishable. Eyes very prominent. Vomerine teeth opposite middle of choanæ, which equal ostia pharyngea. Tongue round, slightly emarginate. Parotoid gland flat, descending on the side. Skin tuberculous, especially on the sides; sometimes a slight cryptiferous thickening of integument of tibia; none on the sides of the pectoral region. A posttympanic and an antepectoral fold. Abdomen slightly rugose; gular region smooth. Cuneiform process elongate. Toes fully palmate.

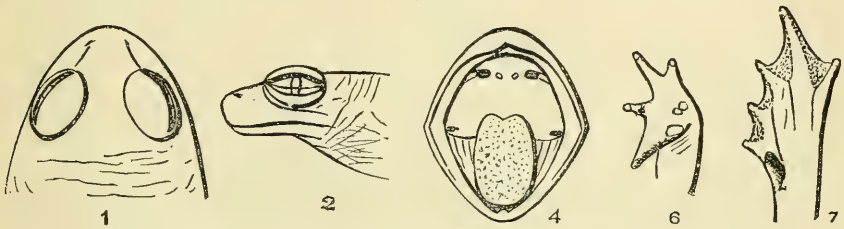

FIG. 75. *Scaphiopus couchii varius*, Cope. 5893; nat. size. Cape St. Lucas, Cal.

Color above yellowish, with irregular brown bands, which converge between and behind the orbits; others diverge on the flanks, beginning at the orbits; one from same point to hip and one on canthus rostralis. There is a confluence of dorsal bands near the sacrum. A light band on outer face of tarsus and toe; hand yellowish.

Measurements of No. 13629.

	M.
Length of head and body	.061
Length of head, including tympana	.020
Width of head at borders of tympana	.027
Length of fore limb	.0315
Length of hind limb	.0606
Length of tibia	.021
Length of tarsus	.011
Length of rest of posterior foot	.024

This species is intermediate in its characters between the *S. holbrookii* and the other species of the genus. The frontoparietal interorbital space is wider than in the latter, but not so wide as in the former. The tibia is very short, giving the animal a more squat appearance than the *S. hammondii*.

In the typical specimen the labial border projected beyond the line of the muzzle, so that the profile sloped to it downwards and forwards. I have seen no second specimen like it, but specimens which agree with it in every other respect occur in the same zoological district. I am inclined to think that this peculiarity of the type specimen (which is not represented in Baird's plate, *l. c.*) is only an individual one. The other forms pass directly into each other.

The range of this species is the southern part of the Sonoran district and the corresponding part of the Lower Californian. Within the limits of the United States it has been found only in southwest Texas.

Scaphiopus couchii Bd.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
	1	Matamoros, Mex		Lieutenant Couch (Berlandier collection).	
5893	3	Cape Saint Lucas, Cal		John Xantus	Alcoholic.
12657	13	La Paz, Cal	1882	L. Belding	Do.
13629	2	Helotes, Bexar County, Tex.		G. W. Marnock	Do.
	3	(?)		(?)	Do.

SPEA Cope.

Journal Academy Philadelphia (2), VI, 1886, p. 81.

Cranial derm free from cranium; the latter generally with a frontoparietal fontanelle; vomerine teeth present; toes webbed; cuneiform process large.

In this genus we have permanently preserved characters which define an immature stage of Scaphiopus. In one of the subspecies of the *S. hammondii* the ossification of the cranium has progressed so far as to close the frontoparietal fontanelle, but not so as to penetrate the

cranial integument. The species belong to the western and southwestern parts of the nearctic realm. They are distinguished as follows:

a. Tympanic disk distinct; no gland on tibia.
Interorbital width narrow, entering length of tibia four times; vomerine teeth between choanæ; color generally dark, with or without pale stripes. *S. hammondii.*

aa. Tympanic disk concealed; a large gland on the upper side of the tibia.
Interorbital width narrow, entering tibia three times; vomerine teeth a little posterior to nares; colors pale..... *S. multiplicata.*

SPEA HAMMONDII Baird.

Cope, Journ. Ac. Phila. (2), VI, 1866, p. 81.

Scaphiopus hammondii Baird, Rept. Expl. Surv., IV, Reptil., 1859, Pl. 28, fig. 2; Cope, Proceed. Ac. Phila., 1863, p. 53; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 435.
Scaphiopus bombifrons Cope, Proceed. Ac. Phila., 1863, p. 53; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 435.
Spea bombifrons Cope, Journ. Ac. Phila. (2) VI, 1866, p. 81.
Spea stagnalis Cope, U. S. G. G. Surv. W. of 100th Merid., V, Zool., p. 525, Pl. 25, figs. 6–8.
Scaphiopus stagnalis Boulenger, Cat. Batr., Sal. Brit. Mus., 1882, p. 436.
Scaphiopus dugesii Brocchi, Bull. Soc. Philom. (7), III, 1879, p. 23, and Miss. Sci. Mex., Batr., p. 94, Pl. 9, fig. 4; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 436.

This is a widely distributed and variable species, presenting such diversity in some respects as to be interesting as an example of the appearance of important characters in the course of descent. It is interesting also from its habits, adapted as they are to the exigencies of a dry climate, in which the opportunity for aquatic life is precarious, and the metamorphosis correspondingly liable to modification.

I include three subspecies under the common head, which are defined as follows:

Generally no frontoparietal fontanelle; head plane above; a longitudinal pale band on each side of back; larger; skin tubercular..... *S. h. intermontana.*
A frontoparietal fontanelle; head plane or convex above; no longitudinal light bands; skin smoother; smaller..... *S. h. hammondii.*
A frontoparietal fontanelle; head very convex at the interorbital region; skin nearly smooth; colors pale; size least..... *S. h. bombifrons.*

I had first placed the *S. h. intermontana* in the genus Scaphiopus, while the two other subspecies were placed with the *S. multiplicata* in a distinct genus, Spea, which was characterized by the presence of a frontoparietal fontanelle. This character is generally constant, although its inconstancy as a specific character is to be expected somewhere. The genus Spea is the seat of the failure of this generic character to coincide with the other definitions of a species. In one of the four specimens of the subspecies Intermontanus I find the fontanelle present, while in three it is absent. In a fifth specimen it is represented by a fissure between the frontoparietal bones.

The *S. h. bombifrons* appears to be, at first examination, a well defined species. The interorbital protuberance is a striking character,

The tibia is also shorter in typical examples, measuring only three times the interorbital width. This measurement is partly due to the interorbital enlargement. The skin is less tubercular and the colors are paler. The form has an especial geographical range. But I find specimens from different parts of the West which connect this form with the true *S. hammondii*. Such are specimens collected by Dr. Hayden in the valley of the Great Colorado, in eastern Utah, and others obtained by myself at Sante Fe, N. Mex. In some of the former the interorbital width enters the length of the tibia three and a half times.

The *Spea stagnalis* is known as yet from young specimens only, which have but recently passed their metamorphosis. The principal peculiarity which characterizes them is the minute size of the ostia pharyngea of the Eustachian tubes. I suspect this to be a character of immaturity, as I find a similar state of affairs in some of the young specimens of *Scaphiopus couchii* in the collection.

Spea hammondii intermontana Cope.

Proceed. Ac. Phila., 1883, p. 14.

I took a specimen of this species within the limits of Salt Lake City, and subsequently obtained three or four specimens from Pyramid Lake, Nevada. The sides and much of the dorsal region are covered with rather large tubercles closely placed. The frontoparietal bones, though ossified, are not roughened, as in the species of Scaphiopus. It is nearest the *S. couchii* (from near San Antonio, Tex.). In that species the vomerine teeth are entirely posterior to the internal nares; in this one they are between the posterior borders of the same. The lips are not cross barred, as in the *S. couchii;* and the superior region has two pale lines on each side. In *S. couchii* these lines are replaced by a coarse marbling. As compared with the *Spea hammondii*, this frog differs in its larger size, lighter colors, and the presence of the superior pair of light lines.

FIG. 76. *Spea hammondii intermontana*. No. 10926. Ft. Walla Walla; ½.

It represents the *S. hammondi* in more northern regions, and the complete cranial ossification and larger size mark it as a more fully developed form.

I found it associated with *Bufo columbiensis* in a pond near the shore of Pyramid Lake. Like other allied species, it was very noisy, almost obscuring the voice of the less vociferous Bufo.

Measurements.

	M.
Length of head and body	.062
Length of head, including tympana	.016
Width of head, including tympana	.028
Length of fore limb from axilla	.030
Length of hind limb from groin	.070
Length of tibia	.023
Length of tarsus	.012
Length of remainder of foot	.028

Spea hammondii intermontana Cope.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8100	1	Provo, Utah		Dr. H. C. Yarrow	
10926	1	Fort Walla Walla, Wash.		Capt. C. Bendire	

Spea hammondii hammondii Baird.

(Plate XLVI, fig. 8; XLIX, fig. 18; LXVI, fig. 1.)

Cope, Journ. Ac. Phila. (2), VI, 1866, p. 81; Proceed. Ac. Phila., 1883, p. 14.

Scaphiopus hammondii Baird, Rept. Expl. Surv., IV., Reptil, 1859, Pl. 28, fig. 2; Cope, Proc. Ac. Phila., 1863, p. 53; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 435.

Spea stagnalis Cope, Yarrow's Rept., V, Zool., p. 525, Pl. 25, fig. 6–8.

Scaphiopus stagnalis Boulenger, *l. c.*, p. 436.

Scaphiopus dugesi Brocchi, Bull. Soc. Philom. (7), III, 1879, p. 23, and Miss. Sc. Mex., Batr., p. 94, Pl. 9, fig. 4; Boulenger, *l. c.*, p. 436.

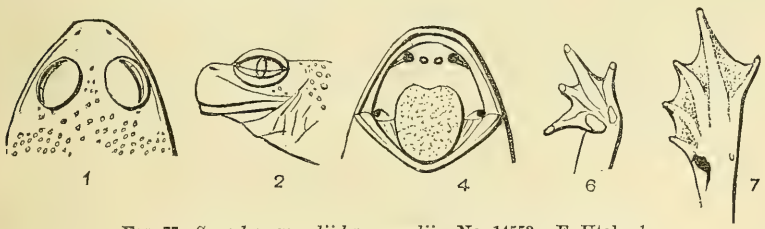

FIG. 77. *Spea hammondii hammondii.* No. 14553. E. Utah; ½.

Maxillary outline acuminate oval; muzzle somewhat truncate, perpendicular in profile. Region of canthus rostralis concave; front plane or a little concave, with a weak ridge on each side, which is most distinct posteriorly; the width one-fourth length of tibia, and less from nostril to lip. Eyes prominent; tympanum distinct, one-fourth the extent of the former. A fold behind angle of mouth. Parotoids flat, small; no gland on tibia or pectus. Tongue very large, entire. Choanæ large; vomerine teeth in transverse series between them. Skin roughly tuberculous, especially on the sides; thick on the occiput; below nearly smooth. Cuneiform process produced.

Color above stone-brown in alcohol, with traces of two paler dorsal bands. Tubercles fulvous tipped; extremities shaded with the same. Below whitish, immaculate.

Measurements of No. 3695.

	M.
Length of head and body	.051
Length of head, including tympana	.0154
Width of head, including tympana	.023
Length of fore-leg from axilla	.0265
Length of hind leg from groin	.055
Length of tibia	.019
Length of tarsus	.009
Length of rest of foot	.022

The range of this species is extensive. It was originally obtained near Redding in northern California. My friend, James S. Lippincott, has sent it to me from the extreme south of California, San Diego. The Smithsonian Institution has a slightly differentiated variety from Chihuahua, and specimens from my friend, Dr. Dugés, from Guanajuato, Mexico, are the same. I suspect that the *Scaphiopus dugesi* Brocchi from that locality is the same species.

Abundant in July and August, when it deposits its eggs in the pools of rain-water. It is very noisy at such times, and the open lots in the city of Santa Fe resound with its cries. These are much like those of the *Scaphiopus holbrookii.*

Spea hammondii hammondii Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
9453	1	California		Dr. J. G. Cooper	Alcoholic.
8559	3	Alto dos Utas, N. Mex.	Sept. —, 1874	Prof. E. D. Cope	Alc. type.
8653	1	Utah	1872	Dr. H. C. Yarrow	Alcoholic.
9628	1	California	Aug. —, 1875	do	Do.
3695	1	Fort Redding, Cal		Dr. J. F. Hammond, U. S. A.	Do.

Spea hammondii bombifrons Cope.

(Plates 51, fig. 17; 68, fig. 1a.)

Cope, Journ. Ac. Phila. (2), VI, 1886, p. 81.

Scaphiopus bombifrons Cope, Proc. Ac. Phila., 1863, p. 53; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 435.

Outline of maxillæ acuminate oval; muzzle truncate, elevated, thickened transversely; profile or vertex arched, of front concave; canthus rostralis replaced by a concavity. Tympanum concealed or scarcely visible; parotoid flat, small. No gland on tibia or pectus. Tongue entire. Vomerine teeth in oblique fasiculi or short series between choanæ; these equal ostia pharyngea. Skin nearly smooth, roughest on the sides. Cuneiform process produced. Palmation of toes deeply repand.

Color in spirits, pale ashen or brown, with numerous plumbeous vermiculations, which are aggregated into a blotch on the scapular region, which has a pale space below it. Limbs vermiculated; outer border of tarsus and foot light. A dark spot on canthus rostralis.

This species has the most northern range of those found west of the Mississippi, and is especially characteristic of the elevated plains. It ranges from northern Texas to Montana. It resembles very closely half-grown specimens of *Bufo cognatus* of the same region, so as to constitute it a mimetic analogue.

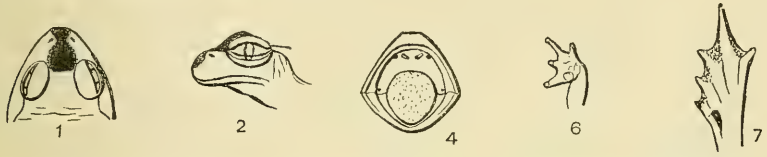

FIG. 78. *Spea hammondii bombifrons* Cope. 9943, nat. size. Camp Thorne, Yellowstone R.

Measurements of No. 3520.

	M.
Length of head and body	.043
Length of head, including tympana	.012
Width of head, including tympana	.016
Length of fore-leg from axilla	.020
Length of hind leg from groin	.0445
Length of tarsus	.007
Length of tibia	.014
Length of rest of foot	.017

The specimen 9943, from the Yellowstone River, is an excellent illustration of the mode of origin of corneous epidermis. The end of the muzzle and the frontal convexity are covered with a layer of black horn, each forming an oval shield, which meets the other on the top of the snout. This is probably a result of the constant pressure and friction of the earth when the animal is burrowing in it. Although the animal burrows with the hinder limbs, the muzzle is naturally used in keeping the passage-way open to the surface. The character is not constant.

This species is characteristic of the northern parts of the plains and Great Basin. I found it especially common in the region north of the Missouri River and eastward of Fort Benton. Before my arrival there rain had fallen, and the ruts of the wagon-trails were filled with water. These ditches contained numerous examples of this species, together with *Chorophilus triseriatus*, *Bufo cognatus*, and *Amblystoma tigrinum*. Their metamorphosis was completed by that time (August 20), although some of the specimens were small.

In Idaho, near latitude 43° 30′, is situated a body of water known as Market Lake. Its extent is variable, for it is said to be dependent for its water supply on the overflows of the Snake River, which is a few miles distant to the eastward. An old channel leads from the river to the lake, giving probability to the statement. At the time of my passage through the region the water was unusually high, for a portion of the stage road, with parts of numerous telegraph poles, was submerged. The lake appeared to be about ten miles long by six in width. The country surrounding it is arid, and the sand, which represents soil, rests

on a basis of lava. The stage halted for a short time to enable me to examine the shore of the lake. I found it to be lined with a windrow of grasshoppers (*Caloptenus spretus*) which had fallen into the water and been washed up, some living, others dead. Among them I found numerous large fat larvæ of *Spea bombifrons* occupying small spaces which they had cleared, quite out of the reach of the water. Their limbs were nearly fully grown, while their tails had suffered no absorption, and their jaws were toothless and cartilaginous; some quite larval in form, others with wider gape. They were engaged in eating the grasshoppers, and I detected several specimens with the entire insects in their mouths. In some instances the grasshoppers' bodies were too large and projected from their mouths. These precocious larvæ were evidently air-breathers, and hopped about, presenting a curious appearance as they dragged their large tails after them. I found some adult specimens of *Amblystoma mavortium* also along the water's edge. These observations were made on the 11th of August, 1876.

Spea hammondii bombifrons Cope.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
	1	Blackfoot Fork, Mont		F. V. Hayden	
3704	1	Fort Union, Dak		E. J. Dennis	
3520	1	Platte River, 200 miles west of Fort Kearney.		W. S. Wood	
3703	1	Llano Estacado		Capt. J. Pope	
9943	1	Camp Thorne, Yellowstone.		(?)	
	1	Fort Benton, Mont		E. D. Cope	

SPEA MULTIPLICATA Cope.

Spea multiplicata Cope, Journ. Ac. Phila. (2), VI, 1866, p. 81.
Scaphiopus multiplicatus Cope, Proceed. Ac. Phila., 1863, p. 52; Brocchi, Mis. Sci. Mex. Batr., p. 25; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 436.

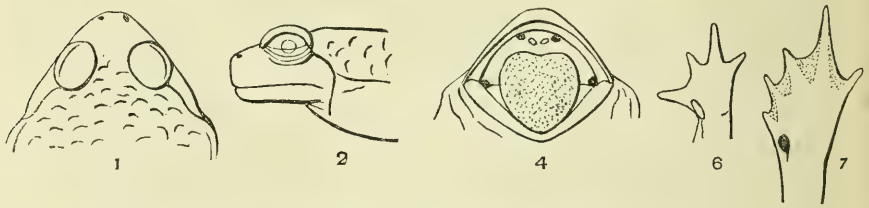

Fig. 79. *Spea multiplicata*. No. 3694. Valley of Mexico; ½.

Form broad, squat. Head very short; profile rapidly descending; maxillary outlines acuminate, oval; muzzle thick, rounded. An open frontoparietal fontanelle. Vomerine fascicles just posterior to the line

connecting the posterior nares. Eyes very prominent. From these a strong fold passes the posterior to the angle of the mouth and across the gular region; tympanum covered by a portion of the parotoid gland anterior to this. Parotoid proper very large, extending beyond scapula, bent upon the side; bounded inferiorly by a strong fold, which extends from the one above mentioned to the groin. Below this, on the sides, are two or more other folds. Skin of upper surfaces coarsely tuberculous; that of the crown thick, of the extremities nearly smooth. A large gland occupies most of length of tibia. Abdomen minutely, pubic region coarsely, rugose. Cuneiform process rather short, very prominent. Choanæ smaller than ostia pharyngea. Tongue entire, with a narrow free anterior border, one-third free posteriorly. Extended heel reaching front of humerus; tibia three times as long as interorbital width. Three phalanges of fourth toe free from web. Color in spirits; above ashy brown, below yellowish ash.

Measurements of No. 3694.

	M.
Length of head and body	.055
Length of head to parotoid fold	.015
Width of head at canthus oris	.023
Length of fore limb from axilla	.023
Length of hind limb from groin	.052
Length of tibia	.0175
Length of tarsus	.0092
Length of rest of hind foot	.0204

The characters which distinguish this species are numerous. In its general appearance it has a great resemblance to the *Bufo compactilis* of the same country. But one specimen is known.

No. 3694; one specimen; Valley of Mexico; J. Potts; alcoholic.

CYSTIGNATHIDÆ.*

Ranidæ, part., *Cystignathidæ*, part., *Discoglossidæ*, part., *Alytidæ*, part., *Uperoliidæ*, *Bombinatoridæ*, part., *Hylodidæ*, part., Günther, Cat. Batr. Sal.

Cystignathidæ Cope, Nat. Hist. Rev., 1865, plus *Scaphiopodidæ*, part.

Cystignathidæ Cope; Journ. Ac. Phila. (2), VI, 1866; Boulenger, Cat. Batr. Sal., Brit. Mus., ii ed. 1882.

Bombinatoridæ, part., *Plectromantidæ*, *Alytidæ*, part., *Polypedatidæ*, part., *Ranidæ*, part., *Discoglossidæ*, part., Mivart, Proceed. Zool. Soc., 1869.

Vertebræ procœlous; no ribs; sacral diapophyses cylindrical, obtrihedral or slightly depressed distally, inclined upwards. Urostyle separate, attached to two condyles, without diapophyses. Terminal phalanges conti uous, either uniformly conic, or with divergent terminal processes or their rudiments. Sternum distinct. No teeth on the mandible.

This, after the Hylidæ the most extensive family of the Arcifera, embraces one hundred and fifty-six species, which represent thirty-seven generic types.

The most completely developed genus exhibits a cranium without

* Plates 70, 71.

fontanelle and with complete ethmoid arch, and a styloid osseous xiphisternum, with terminal cartilaginous disk; the auditory organs perfectly developed; the lowest, undeveloped ethmoid arch and frontoparietal roof, and disciform cartilaginous xiphisternum without style, with Eustachian tubes and membranum tympani wanting. Accompanying this succession, we have four modifications of the family structure to adapt to as many modes of life: the aquatic, the terrestrial, the arboreal, and the subterranean. As the earth's surface is the common medium between the above extremes, so the species of terrestrial habits furnish us with none of the adaptive extremes of structure, but remain an intermediate group, from which the succession of structures, interrupted, it is true, passes towards the divergent types. Developmental structures accompany and confirm the adaptive, but by no means always coincide.

The aquatic habit is attained when the digits behind are not only webbed, but when the external metatarsi are separated by membrane also; the arboreal, when the terminal phalanges are furnished with a terminal transverse limb, which supports an adhesive disk. The subterranean is shortened, and furnished with a great development of the first digit or prepollex of the tarsus, which is covered by a corneous sheath, and serves as a spade. The first type may be combined with the third, as in Mixophyes and Chiroleptes, or either may be furnished with a bony overroofing of the temporal muscles, and penetration of its integuments by the hyperossification of the cranium.

The fossorial spur is weak in Helioporus and Paludicola, weaker in Mitrolysis, and just represented in Ceratophrys. The palmate foot is diminished in Calyptocephalus, reduced in Mixophyes and Chiroleptes, and represented by a trace in Hylorhina and Limnomedusa. The undeveloped ear is seen in Telmatobius and in Alsodes.

The variations in the development of the thumb are not so striking as in the Hylidæ. In Gnathophysa, Cystignathus, and Ceratophrys the trapezium supports an osseous metacarpal and obtuse phalange, which are concealed in a large tubercle. In Mixophyes, on the other hand, the metacarpal is slender, entirely cartilaginous, and does not support a phalange. There is nowhere a spur, as in Hypsiboas.

With regard to the dermal attachments, the following important varieties occur; in the family generally, but especially among Hylodes and Cystignathi, the dorsolateral septum is placed especially high up:

Pseudes.—Septa in Pseudis as in Rana; in Lysapus the lateroventral line is a little widened. In *Mixophyes fasciolatus* the lateroventrals are very wide, and leave the ventral free space very narrow behind the middle.

Ceratophrydes.—In Ceratophrys the lateral septa are narrow, and there are two posterior abdominal transverse septa, similar to those attached to the sternum. In *Ceratophrys ornata* these are wanting, but the dorsolateral line is very broad.

Criniæ.—Among these animals I have examined species of Heliophorus, Platyplectrum, Crinia, Borborocœtes, Eusophus, and Hyperolia, and in none can I find more than lateral traces of the epicoracoid and coracoid septa, except in the *Hyperolia marmorata*, where they are complete. The posterior abdominal is well developed in *Eusophus nebulosus.*

Pleurodemæ.—Ventrolateral low down, and posterior abdominal well developed in *Pleurodema bibronii.*

Hylodes.—Dorsolateral and ventrolateral far apart; the transverse posterior abdominal septum in the species of Lithodytes, in *Ephirexis longipes*, in *Enhydrobius vomerinus* (Elosia Girard) and *Hypodictyon ridens.* I have not found it in *Lithodytes conspicillatus* Gthr., *Enhydrobius parvus*, and *Limnocharis fuscus* Bell (*Elosia nasus* Girard).

Cystignathi.—In all the species the structure is similar to that of Rana, except in the approximation of the dorsolateral lines, and the presence of the postabdominal septum, which is continuous with the lateroventrals, and is indicated externally in several of the species by a fold in its line of attachment.

The accompanying table exhibits the affinities of the genera and the groups into which they naturally fall.

This family was first characterized by the author in Proceedings Academy Natural Sciences, 1863, 46; excluding, however, the genera Ceratophrys and Tomopterna; and subsequently more exactly in the Natural History Review, 1865. Several changes, approximations to nature, were proposed by me in 1866. Boulenger adopted this family as I defined it (Cat. Brit. Mus., 1882), but modified the extent and definitions of the genera materially.

Group I. Pseudes.—Frontoparietal bones fully developed; toes webbed, external metatarsi free; terminal phalanges acute; sternum a cartilaginous plate; ear perfectly developed; tongue broad, entire, adherent.

Cephalic derm distinct; vomerine teeth; no cuneiform shovel or lumbar gland; prefrontals closely united; pupil horizontal; no digital dilatations ..... *Pseudis* Wagler.

Cephalic derm distinct; vomerine teeth; no cuneiform shovel or lumbar gland; prefrontals widely separated from each other and frontoparietals; ends of digits dilated..... *Lysapsus* Cope.

Cephalic derm distinct; vomerine teeth; fingers and toes webbed; terminal phalanges bifurcate; supporting disks.. *Centrolene* Esp.

Cephalic derm distinct; vomerine teeth; a cuneiform shovel; no lumbar gland; prefrontals not closely united; pupil vertical ..... *Mixophyes* Gthr.

Cephalic derm distinct; vomerine teeth; no cuneiform shovel; a lumbar gland; prefrontals well united, transverse. ..... *Cyclorhamphus* Tsch.

Cephalic derm involved in a rugose cranial ossification, temporal fossa overarched, completing postorbital arch; vomerine teeth; no cuneiform shovel or lumbar gland; prefrontals extensively unitedand prolonged posteriorly..... *Calyptocephalus* D. & B.

Group II. CERATOPHRYDES.—Frontoparietal bones fully developed; toes free or slightly webbed; the external metatarsi bound; terminal phalanges simple; sternum a cartilaginous plate (so far known, emarginate); ear perfectly developed; tongue entire, little free.

a. Cephalic derm distinct; no postorbital arch.

Pupil vertical; prefrontals well separated; vomerine teeth; toes webbed; inner finger opposable ..... *Mitrolysis** Cope

Pupil horizontal; prefrontals more or less united; vomerine teeth: toes webbed; inner finger not opposable; abdominal derm areolate; a strong cuneiform shovel ..... *Odontophrynus* R. & L.

Prefrontals widely separated; eyelids with dermal prolongation; vomerine teeth; toes nearly free; cranium elevated; form toad-like; inner finger not opposable ..... *Stombus* † Boie.

Prefrontals in close contact; eyelids not prolonged; vomerine teeth on palatine arch; toes free; cranium broad; pupil horizontal; form squat; abdomen smooth ..... *Zachænus* Cope.

aa. Cranial derm involved in ossification; no postorbital arch.

Pupil vertical; thumb opposed; toes webbed; vomerine teeth; prefontals separated; no dorsal shield ..... *Chiroleptes* ‡ Gthr.

aaa. Cephalic derm involved in cranial ossification; a postorbital bony arch.

Similar to Ceratophrys as below, but without dorsal dermal osseous shield ..... *Phrynocerus* Tsch.

Prefrontals wholly or in part separated; eyelids with a dermal prolongation; vomerine teeth; toes more or less palmate; cranium elevated; form toad-like; inner finger not opposable; pupil transverse; a dorsal dermal osseous shield ..... *Ceratophrys* Boie.

Group III. CRINIÆ.—Frontoparietal bones embracing a large fontanelle; cephalic derm free; external metatarsi bound; terminal phalanges simple; prefrontals never closely united, rarely in contact; *sternum not distinguishable into style and disk*, broad, emarginate, cartilaginous.

a. Ethmoid bone with superior arch complete; toes webbed.

Pupil erect; vomerine teeth ..... *Helioporus* Gray.

Auditory apparatus minute; vomerine teeth; pupil horizontal; sternum with a proximal semiossified portion ..... *Cophœus* § Cope.

aa. Ethmoid arch complete, or nearly so; digits free; no cuneiform shovel.

Large parotoid glands; no vomerine teeth; pupil horizontal. ..... *Hyperolia* Gray.

No parotoid glands; vomerine teeth in transverse series; xiphisternum broad; pupil horizontal ..... *Borborocœtes* ‖ Bell.

No parotoid glands; pupil erect; sternum a plate ..... *Perialia* Gray.

No parotoid glands; pupil horizontal; vomerine teeth wanting or in minute fasciculi; sternum slender, without bony deposit; abdominal integument usually areolate ..... *Crinia* Tsch.

aaa. Ethmoid arch cartilaginous above; digits free; no shovel.

No parotoids; vomerine teeth; pupil round; auditory organs rudimental ..... *Eusophus* Cope.

aaaa. Ethmoid arch? No metatarsal shovel; "auditory organs wanting;" toes slightly webbed.

Vomerine teeth; no parotoids ..... *Alsodes* Bell.

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* Type *Chiroleptes albopunctatus* Gthr.

† Type *Ceratophrys boiei* Wied.

‡ *Phractops* Peters.

§ *Telmatobius* Boulenger, not of Wiegmann.

‖ Includes *Limnodynastes* Fitz., Günther.

Group IV. Pleurodem.e.—Frontoparietal bones embracing a fontanelle; auditory apparatus developed; digits free, or slightly webbed; external metatarsals bound; terminal phalanges simple; sternum an osseous style, with one or more distinct terminal cartilage disks; tongue entire; cephalic derm free.

a. Inguinal glands; pupil horizontal; sternal cartilage emarginate or bifurcate.
Vomerine teeth; prefrontals well separated; metatarsal tubercles minute; terminal phalanges short ..... *Pleurodema* Tsch.

aa. No inguinal glands; pupil horizontal.
No vomerine teeth; prefrontals entirely separated; terminal phalanges short ..... *Liuperus* D. & B.

aaa. No inguinal glands; sternal cartilage entire; pupil erect.
Vomerine teeth; prefrontals widely separated by the osseous ethmoid; terminal phalanges elongate; limbs elongate.... *Hylorhina* Bell.

Group V. Hylodes.—Digits free, or nearly so; external metatarsi bound; *terminal phalanges with a transverse limb*, which supports dermal disks; sternum without style, scutiform, emarginate or bilobed, osseous or cartilaginous.

1. A frontoparietal fontanelle.
No vomerine teeth or tarsal spurs; prefrontal bones wide, uniting on the middle line..... *Malachylodes* Cope.

2. No frontoparietal fontanelle.
a. Prefrontals well separated, rarely the convexities of the inner borders in contact.
b. Manubrium cartilaginous.
Muzzle and canthus rostralis angulated, projecting; vomerine teeth; digital dilatation small..... *Enhydrobius* Wagl.
Muzzle and canthus rostralis contracted, little marked; vomerine teeth; digital dilatations large..... *Epirhexis* Cope.
bb. Manubrium osseous, styloid.
Muzzle and canthus rostralis angulated; no vomerine teeth ..... *Limnocharis* Bell.
aa. Prefrontals united throughout by close suture, and usually in contact with frontoparietals.
No vomerine teeth..... *Syrrhophus* Cope.
Vomerine teeth; abdomen smooth..... *Lithodytes* Cope.
No vomerine teeth; belly areolate ..... *Hypodictyon* Cope.
Vomerine teeth; abdomen areolate ..... *Hylodes* Fitz.

Group VI. Cystignathi.—Frontoparietals and auditory apparatus fully developed; cephalic derm free; external metatarsi bound, digits free, terminal phalanges simple; sternum a distinctly defined slender osseous style, with distal cartilaginous disk; toes free.

a. Xiphisternal style emarginate, and with two distal cartilaginous disks.
Vomerine teeth wanting; no tarsal spurs; inguinal glands ..... *Bubonias* Cope.
Vomerine teeth present; no tarsal spurs; inguinal glands ..... *Edalorhina* Esp.
No parotoid or vomerine teeth; isolated inguinal glands; two acute metatarsal spurs; pupil horizontal..... *Paludicola* Wagl.

aa. Xiphisternal style and distal disk undivided.
No inguinal glands; pupil horizontal ..... *Leptodactylus* Fitz.
Glandular aggregations on the loins; pupil horizontal ..... *Cystignathus* Wagl.
No glands; pupil erect ..... *Limnomedusa* Cope.
No glands; pupil horizontal; auditory apparatus atrophied. ..... *Telmatobius* Wiegm.

	Regio Australis.	Regio Neotropica.			
		Chili and S. of La Plata.	Central.	Mexican.	West Indian.
Cystignathi	0	2	29	5	3
Hylodes	0	0	24	26	9
Ceratophrydes	7	4	6	0	0
Pseudes	1	3	3	0	0
Pleurodemæ	0	5	3	1	0
Criniæ	13	10	2	0	0

There are then known twenty-one Australian species, of which all but two possess an incomplete cranium and none a bony xiphisternal style. In the Patagonian subregion twenty-four species, of which ten exhibit an incomplete cranium, and five a complete bony xiphisternal style; in the Brazilian subregion sixty-seven species, of which only six have an incomplete brain case, and twenty-four the osseous xiphisternal style; Mexico, thirty-two species with complete cranium, and one of these with style; the West Indies with twelve, none having the fontanelle, and three the style.

	R. Australis.	S. R. Patachonica.	S. R. Brazil.	S. R. Mexic.	S. R Ind. Occ.
Total	25	13	53	4	11
Prefrontals fully developed	0	3	*22	27	10
Ear imperfect	1	4	0	0	0
No vomerine teeth	5	1	15	7	0
Toes webbed	8	2	6	0	0
Fossorial shovel	7	3	2	0	0

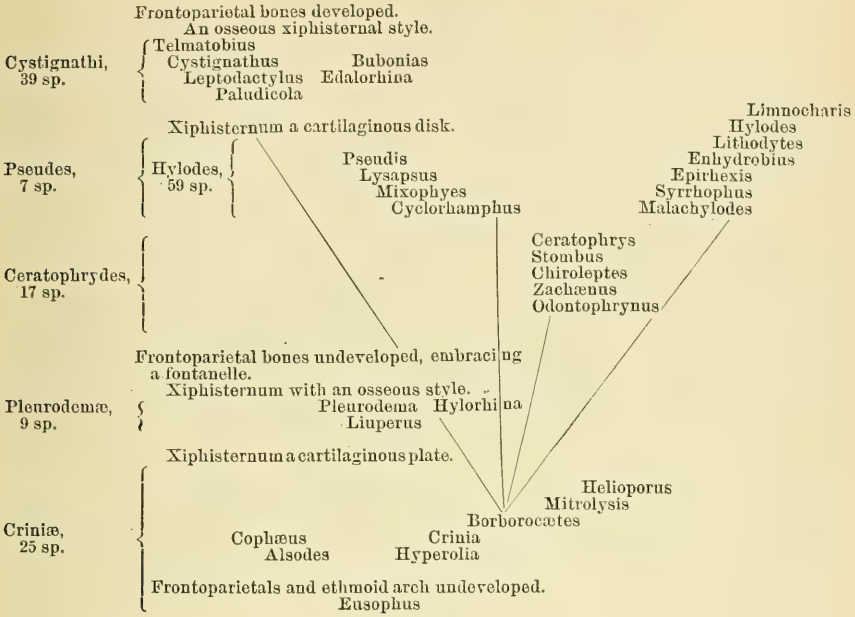
*Approximate.

In regard to the cranial development, the West Indian region is preeminent in this family, as in the Hylidæ; the Brazilian inferior, and the Australian vastly below all; the degradation appearing in a certain degree regular. In the lack of vomerine teeth (a feature of immaturity) South Brazilian and Argentine forms predominate. In possession of the raniform xiphisternum the West Indian and Mexican subregions show fewer representatives than the Brazilian. There are none in the Australian.

One species—*Lithodytes ricordii*—wanders from the R. Neotropica into the southern projection—Florida—of North America, and two others, *Lithodytes latrans* and *Syrrhophus marnockii*, have a distribution in Southwest Texas; no others are known to occur beyond the borders already stated. No species is common to the R. R. Australis and Neotropica, and but one genus—Borborocætes. Two Brazilian species occur in the Southern West Indies and two in Southern Mexico; probably three of the same country must be included in the Buenos Ayrean list.

As yet we are acquainted with the fossil remains of but one species of Cystignathidæ—a Ceratophrys, from a Brazilian cave. It has been

regarded as identical with the *C. dorsata* by Günther (Ann. Mag. Nat. Hist., 1859, Pl. xv).



LITHODYTES Cope.

Proceed. Ac. Phila., 1862, p. 153; Journ. Ac. Phila. (2), VI, p., 97.

Hylodes pars, auctorum.

Terminal phalanges T-shaped; fingers and toes free; no enlarged metatarsal tubercle. Omosternum cartilaginous. Sternum a cartilaginous plate. Prefrontal bones uniting on the median line of the muzzle. Belly smooth.

This genus differs from Hylodes only in the smooth, as distinguished from the granular, or areolated, belly of the latter. Its species are numerous and inhabit principally the equatorial and northern parts of the Neotropical realm. But two are found in the United States: the *L. latrans* at the southwestern border, and the *L. ricordii* at the extreme southeast. The latter is a West Indian species; the former probably occurs in Mexico, but its existence there has not yet been ascertained positively.

α. Vomerine in two short patches between the nares.
Form robust; muzzle short, wide; upper surfaces with brown spots.....*L. latrans.*
$\alpha\alpha$. Vomerine teeth in two long transverse curved series posterior to the internal nares.
Form elongate; muzzle acute; spotted above.....*L. ricordii.*

LITHODYTES LATRANS Cope.

(Plates 51, fig. 15; 71, fig. 22.)

Amer. Nat., 1878, p. 186; Bull. U. S. Nat. Mus. No. 17, 1880, p. 25.

Size rather large; frontoparietal region flat, its width equal to the vertical diameter of the membranum tympani. Skin smooth, that of the abdomen thrown into a disk by a circular fold. Digital dilitations small on all the feet. The toes have no dermal free margins; those of the hand are long, while those of the foot are rather short. The fourth finger is as large as the forearm and exceeds the thumb, which in turn is considerably longer than the second finger. There are two strong palmar tubercles, of which the external is divided into two by a longitudinal groove. There are two solar tubercles, and the entocuneiform is prominent and obtuse. The muzzle marks a point beyond the middle of the tarsus of the extended hind limb. The tarsus to the entocuneiform is just half as long as the remainder of the foot. There are prominent tubercles on the inferior side of the digits of both extremities. The head is wide and flat and the loreal region oblique. The nasal region is flat and gently decurved and the lip projects a little beyond the muzzle. The long diameter of the eye equals the length from its border to the external nostril, which is very near the end of the muzzle, and exceeds the long or vertical diameter of the membranum tympani by one-half of the latter. The width of the tympanic membrane is five-sixths of its height. The tongue is subround. The ostia pharyngea are large, but smaller than the choanæ. The vomerine teeth are in two short, nearly transverse patches, on elevated bases, their apices nearly in line with the posterior border of the choanæ. In younger individuals the choanæ are obliquely longitudinal.

Length of head and body, .076^{m}; length of head to line of posterior borders of tympanum, axially .024^{m}; width at latter point, .031^{m}; length of posterior leg, .107^{m}.

Color of superior surfaces brownish-gray, marked with a few large brown spots with pale centers. The largest of these is on each scapular region; a smaller pair is one over the extremity of each sacral transverse process. There are several on the pelvic region and above the groin, one on each eyelid, and one or two on the middle of the nasal region. Another covers the tympanum, and a brown band connects the orbits around the end of the muzzle. There are two large brown spots on the lip, one below the eye and one in front of it. The segments of the limbs have broad cross-bands, excepting the humerus. Below pale, immaculate.

This species is one of the larger forms of the genus. The nasal bones are in contact for most of their length, but diverge a little posteriorly, displaying a small portion of the ethmoid. This is not typical in Lithodytes, but approaches the state of things in Epirhexis.

This frog inhabits the cliffs of the cretaceous limestone which are

found in every direction along the borders and river valleys of the first plateau region of Texas. Mr. G. W. Marnock, who discovered it, informs me that after rains it is very noisy, making the rocks resound with its cry, which is somewhat like a dog's bark. It hides in fissures, and is so difficult to find as to be generally unknown to the country people, who suppose that the voice proceeds from a lizard. According to Mr. Marnock the eggs are hatched in winter, and the tadpoles pass their existence in temporary pools of rain-water which collects in holes in the rocks and at a distance from the creeks.

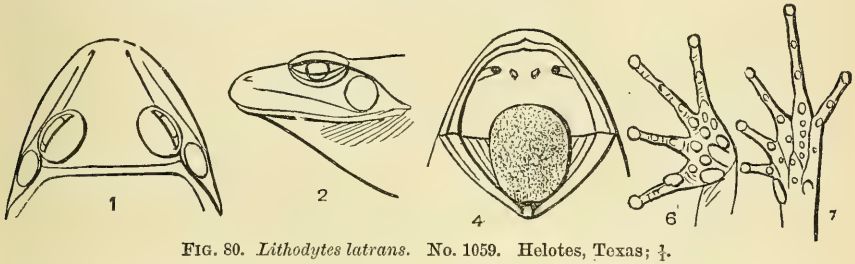


FIG. 80. *Lithodytes latrans*. No. 1059. Helotes, Texas; ¾.

Additional specimens of this species received from Mr. Marnock show that it reaches a larger size than the above specimens indicate. I give the following

Measurements.

	M.
Length of head and body	.094
Length of head, including tympana	.025
Width of head at posterior edge of tympana	.039
Length of fore limb	.055
Length of hind limb	.115
Length of tibia	.039
Length of tarsus	.020
Length of rest of foot	.035

In the large and old specimens a mineral deposit takes place in the skin, as in the *Phyllomedusa seleroderma* Cope and *Stereocyclops incrassatus* Cope. It is especially abundant in the cranial derm, but which is not, as in cases where the ossification appears on the surface of the cranial bones, adherent to the latter.

The *Hylodes augusti* (Dugès MS.), Brocchi Mision Scientifique de Mexique, 1881, from Guanajuato, Mexico, is related to the present animal. I do not know what the specific difference is, unless it be in the form of the vomerine patches, which I can not clearly make out from Brocchi's description.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
10751	1	Bexar County, Tex	Feb. 10, 1880	G. W. Marnock	Alcoholic.
10752	1	do	do	do	Do.
10753	1	do	do	do	Do.
10058	2	do		do	Do.
10529	2	do		do	Do.
13633	1	do		do	Do.

LITHODYTES RICORDII Dum. & Bibr.

Cope, Check-List N. Amer. Batr. Reptil., 1875, p. 31.

Hylodes ricordii Dum. & Bibr., Erp. Gen., VIII, p. 623; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 213.

Head as wide as or wider than the body, longer than broad; the lateral outlines curved; the end of the muzzle abruptly truncated. Ostia pharyngea oval. Vomerine teeth in two long curved series, which commence behind and opposite to the external border of inner nares; they are separated by a considerable space medially. Tongue elongate oval, slightly nicked. A subgular vocal sack. Tympanum half the size of the eye. Skin smooth above and below; sides rugose. Heel reaching the orbit. Digital palettes small. Two metacarpal, two metatarsal tubercles. Brachium longer than or equal to antebrachium.

General color reddish-brown. The loreal region, a band between the eyes, one above the tympanum, and some dorsal spots, darker. Beneath light brownish.

A single specimen from Key West, Florida, is in the National Museum. Its proper habitat is Cuba.

SYRRHOPHUS Cope.

Amer. Nat., 1878, p. 253; Proceed. Amer. Philosoph. Soc., 1876, p. 268.

Sternum a cartilaginous plate, notched; digits free; vomerine teeth none; ear well developed; nasal bones in contact, forming a solid roof over the ethmoid cartilage. Pupil horizontal.

This genus is simply Lithodytes without vomerine teeth. In the former genus the nasals and ethmoid have the structure seen in Elosia. Four species are known, three of which are Mexican in distribution. They differ as follows from each other:

Posterior limbs short, heel to tympanum; head wide; tympanum half orbit; rufous, brown spotted ..... *S. marnochii.*

Posterior limbs longer, heel to front of orbit; head wide, a canthus rostralis; tympanum one-third orbit; brown, pale spotted ..... *S. leprus.*

Posterior limbs longer, heel to front of orbit; head narrow, no canthus rostralis; tympanum one-third orbit; brown, dark spotted ..... *S. cystignathoides.*

Heel to front of orbit; head rather wide, flat; tympanum two-thirds eye-slit; subdigital tubercles large; gray, with black spots ..... *S. verrucipes.*

SYRRHOPHUS MARNOCHII Cope.

(Plate 71, fig. 34.)

Amer. Nat., 1878, p. 253; Bull. U. S. Nat. Mus., 1880, p. 26.

The typical specimen is as large as *Hyla versicolor*, and has a long flat head and remarkably short hind legs. The muzzle is flat and slightly depressed above, and projects a little beyond the edge of the

lip. The nostril is a little behind the apex, and as far in front of the orbit as the long diameter of the latter. Tympanic membrane round, its diameter about half that of eye. Choanæ lateral, equal in size to the ostia pharyngea. Tongue longer than wide, full, entire. Integuments everywhere smooth; on the abdomen a faint discoidal fold. Digits short, moderately expanded and truncate at the extremity. Prominent tubercles at the proximal ends of the phalanges below. First and second anterior toes equal and shorter than fourth. The heel of the appressed hind limb reaches the middle of the tympanum, and the extremity of the tarsus a little anterior to the orbit. The fore limb is relatively longer, the wrist extending beyond the extremity of the muzzle. The tarsus is two fifths the entire length of the posterior foot. The interorbital space is flat and wide, and is but a trifle narrower than the expanse of the sacral diapophyses.

The color of the upper surfaces is a light purplish-brown, closely spotted with rather small closely placed and broadly defined dark brown spots. The spots are less distinct on the head. Inferior surfaces light yellowish, immaculate, this tint commencing as small spots on the pale ground of the sides. Limbs above brown, broadly cross-banded with yellowish· femora behind, light brown with a few light points.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
10161	2	Helotes, Bexar County, Tex.	.....	G. W. Marnock.....	Alcoholic.
13635	1	.....do.....	.....	.....do	Do.

FIG. 81. *Syrrhophus marnockii.* No. 13635. Helotes, Texas; ½.

Measurements

	M.
Length of head and body	.038
Length of head, including tympana	.0123
Width of head, including tympana	.013
Length of fore limb from axilla	.022
Length of hind limb from groin	.045
Length of tibia	.015
Length of tarsus	.0093
Length of rest of foot	.015

Nothing is yet known of the life history of this species. It is probable that, like other species of the genus, it inhabits rocky places. I found the *S. verrucipes* in the bottom of a rocky ravine in the State of Hidalgo, Mexico, under a stone on the borders of a small stream.

HYLIDÆ.*

Vertebræ procœlous. Sacral diapophyses dilated, the simple urostyle articulated to two condyles. External metacarpi bound together. Terminal phalanges articulated inferiorly onto the extremity of the penultimate, globular or swollen proximally, and giving rise, usually from a central emargination, to the curved, acute distal portion, which is of a more compact tissue. Superior plate of ethmoid never covered by frontoparietals, usually produced anteriorly between frontonasals. Ear perfectly developed. Abdominal integument generally areolate.

This family embraces the tree toads of Australia and America. It presents comparatively little structural variety, not containing as undeveloped types as the Cystignathidæ, nor as high ones; it possesses neither earless nor fossorial, nor really aquatic genera.

The adaptive modifications are: First, those which accompany a terrestrial habitat, *i. e.*, the diminution of the digital dilatations and palmation. These occur in regularly increasing degree in a small number of the species of the typical genus Hyla, and are general in and distinctive of two other genera. Second, those which adapt the extremities to grasping a limb by opposition of digits, instead of adhering to a surface by expansion of them in one plane. This first appears possible in Agalychnis, and is structural in Phyllomedusa. Third, those which restrict the light admitted to the retina, first, by the lateral contractility of the pupil; second, by the rendering opaque of the inferior palpebra. The first characterizes the two genera just mentioned, the last occurs in the first two, but is inconstant in the second, and characterizes two other genera. Fourth, that which adapts the female during the breeding season to localities without water, or where perhaps the water contains enemies, by the inversion of the dorsal integument so as to form a sack, in which the eggs are carried. This occurs in and is accepted as characteristic of two genera.

Another feature, which has a functional value, is the union of the abdominal integuments with the superficial fascia of the muscles by an areolar or fibrous net-work, continuous with that of the usual latero-ventral band. The skin of the inferior surfaces of these creatures, as in the raniform tree frogs, has a thickening in numerous close areolæ, the nature and function of which is like that of the digital dilatations, and the derm of the tuber on the thumb of the male Rana, *i. e.*, to secrete an adhesive fluid as aid in maintaining the peculiar positions assumed. In proportion to the development of these is the extent of the abdominal attachment, and hence may be supposed to be adapted for relieving the other areolar connections from the strain of the animal's weight when in an appressed or vertical position. Its uniformity in the burrowing genera of the Bufonidæ and Scaphiopodidæ, and especially on their dorsal surface, rather confirms this view.

This connection is, however, evidently not necessary to the use of the

* Plates 72, 73.

abdominal integument as an adhesive support, as this faculty is nowhere better seen than in the Acris, where derm is free. This creature will adhere for days to a vertical glass plate, not only by the abdomen and digits, but by the interdigital membranes, and will light securely from a long leap on such a surface. Daudin and Duméril have related the same adhesive faculty in *Pelodytes punctatus*, which is not known in regard to the dermal attachments, but has not the abdominal areolæ present in Acris. The extent of the attachment is least where the dilatations are smallest, as follows:

Abdomen entirely attached; 18 sp.
Phyllomedusa four sp. Agalychnis three sp. Trachycephalus two sp. Nototrema one sp. Scytopis two sp. Smilisca baudinii.
Hypsiboas albomarginata, boans. Hyla agrestis, krefftii, phyllochroa.
Posterior half or third of abdomen attached; lateroventral band wide.
Triprion petasatus.
Hyla fusca, arenicolor, gratiosa, versicolor, femoralis, squirella, andersonii, cœrulea.
Ranoidea aurea.
Chorophilus triseriatus.
Less than posterior third abdomen attached; the lateroventrals wide.
Hyla arborea, regilla, lateralis, miotympanum, pickeringii.
Chorophilus nigritus.
Abdomen entirely free.
Hyla leseurei, curta, gracilipes. Acris gryllus.

Of distinguishing features, which are seen in the degree of development of the elements of the skull, there are, first, the development of the o. o. frontoparietalia; second, of the prefrontalia; third, of the superficial cranial rugosities; fourth, of vomerine teeth; fifth, of a postfrontal arch; sixth, of the ethmoid arch.

Whole number of species	183
Frontoparietals fully developed	22
Frontoparietals with rugosities penetrating derm	9
Prefrontals developed	17
No vomerine teeth	6
A postfrontal process	1
Ethmoid incomplete above	1

Of the above characters the lack of vomerine teeth is inconstant in Phyllomedusa, being present in some and wanting in other species.

There is a tendency to the Pseudis and Rana liberation of the outer metatarsus in *Hyla americana*, *hyposticta*, and *dimolops*, and *H. (Ranoidea) aurea*.

Parotoid glands occur in some species of Hylidæ as an extensive stratum of crypts, but never exhibit the definition seen in Bufoniform and some Cystignathid genera. It even occurs in *Scytopis venulosus* irregularly, being sometimes present and sometimes wanting in the female, at least.

The xiphisternum exhibits the form which exists in the greater number of Cystignathidæ, excepting in eight species, where it only lacks the posterior emargination.

The natural genera are as follows:

I. No teeth on the parasphenoid bone.
  1. Pupil horizontal.
    α. A frontoparietal fontanelle; ethmoid not ossified above.
      Toes free ..... *Thoropa* Cope.
    αα. A frontoparietal fontanelle; ethmoid completed.
      Toes free, or nearly so; digital dilatations very small; sacrum little dilated ..... *Chorophilus* Baird.
      Toes fully webbed; digital dilatations minute; sacrum little dilated. ..... *Acris* D. & B.
      Toes webbed; digital disks and sacral diapophyses more dilated; pollex consisting of one or more short concealed phalanges; palpebra transparent ..... *Hyla* Laur.
      Like Hyla, but the dorsal derm introverted forwards, forming a sac. ..... *Nototrema* D. & B.
      Like Hyla, but pollex consisting of phalanges fused into a curved solid exsertible spine; palpebra transparent ..... *Hypsiboas* Wagl.
      Like Hypsiboas, but palpebra reticulate with fibers ..... *Cinclosoopus* Cope.
      Like Hyla, but vomerine teeth wanting ..... *Hylella* R. & L.
    αα. No frontoparietal fontanelle.
      Derm of the head free; no postfrontal process ..... *Scytopis* Cope.
      Derm of the head free; a postfrontal process ..... *Smilisca* Cope.
      Derm of front free; bones exostosed ..... *Osteocephalus* Fitz.
      Derm of the head involved in the ossification; no dermal sac. ..... *Trachycephalus* Tsch.
      Derm of head involved in the ossification; a dorsal sac of the introverted skin ..... *Opisthodelphys* Gthr.
  2. Pupil vertical.
    β. No frontoparietal fontanelle.
      Tongue scarcely free behind; no digits opposable; cranial ossification involving derm ..... *Nyctimantis* Boul.
    ββ. Frontoparietal fontanelle present.
      Tongue extensively free behind; sternum deeply emarginate; digits not opposed when at rest; cranial skin free ..... *Agalychnis* Cope.
      Tongue extensively free; internal digits opposable, more or less free; sternum entire; cranial skin free ..... *Phyllomedusa* Wagl
II. Teeth on the parasphenoid bone.
      Pupil horizontal; vomerine teeth; cranial derm involved in ossification of skull; labial borders produced ..... *Diaglena* Cope.
      Vomerine teeth; toes webbed; derm of head involved in ossification; labial border produced; pupil vertical ..... *Triprion* Cope.

In the series I–2 to Phyllomedusa a final diminution of palmation accompanies continued size of the digital palettes and increase in the length and breadth of the ethmoid and diminution of the frontoparietals, which features, however, are as marked in *Hyla palmata* as in these succeeding types; they carry to its fullest development the cranial peculiarities of the family, and add other features before mentioned; they inhabit the continental subregion of the Neotropical. The other main series (I–1) leads, first, to a fuller development of the frontoparietals, then to an extension of the prefrontals, and finally to covering of the cranium with "dermo-ossification," on the one hand with the superaddition of a dorsal dermal sac, on the other without it. This extreme finds its greatest expansion in the West Indian subregion. A

singular incompleteness of the cranial box seems to mark Thoropa, which has the strong nasal roofing of this second series.

Chorophilus exhibits an affinity to the Cystignathidæ, as does also Thoropa, which represents in inferiority Eusophus in the same family.

The following is the geographical distribution of the genera and species:

	R. Australis.	R. Neotropica.	R. Nearctica.	R. Palæarctica.	R. Æthiopica.	R. Palæotropica.
Triprion		1				
Diaglena		1				
Opisthodelphys		2				
Trachycephalus		5				
Osteocephalus		3				
Nototrema		4				
Scytopis		9				
Nyctimantis		1				
Phyllomedusa		13				
Agalychnis		3				
Smilisca		1				
Centrotelma		3				
Hypsiboas		16				
Hyla	29	60	10	3	0	3
Hylella	2	4				
Acris			1			
Chorophilus		1	5			
Thoropa		1				
Total	31	128	16	3	0	3

The only genus in the above series which is not confined to a zoological realm is Hyla, and the species of this genus are all restricted to their respective regions. *Smilisca baudinii* extends from the Neotropical into the borders of the Nearctic region, and it is possible that *Hyla cærulea* extends from the Australian Islands into those of the Palæotropical archipelago, though the identification of the species may not be strictly correct. According to Bleeker it is found in Java and as far west as Padang, on the west coast of Sumatra.*

The following is a distribution of these generic forms among the districts of the Neotropical region:

	West Indian.	Mexican.	Colombian.	Chilian.	Eastern.
Diaglena		1			
Triprion		1			
Opisthodelphys		1			1
Trachycephalus	4				1
Osteocephalus					3
Nototrema			4		
Scytopis	(1)	2			8
Nyctimantis					1
Phyllomedusa		2			11
Agalychnis		3			
Smilisca		1			
Cinclosoopus					1
Hypsiboas		2	1		15
Hyla	2	17	7	1	36
Hylella		1			3
Chorophilus			? 1		
Thoropa					1
Total	7	31	13	1	80

Our present knowledge, as above, indicates considerable localization in the distribution of genera, and a marked predominance of the eastern

*Over de Reptiliën Fauna vân Sumatra, P. Bleeker, Batavia, 1860, p. 8.

district. But three of the genera found in the latter are known to exist in any other. The poverty of the Chilian district is marked, while West Indian species are nearly all of one genus, the Scytopis noted being the *S. ruber* of Surinam, which occurs in Trinidad. None of the species ever pass these bounds, with the last-mentioned exception, and those of *Scytopis venulosus*, *Hypsiboas albomarginatus* and *xerophyllum*, which occur in the eastern and adjoining portion of the Mexican region. Our knowledge of this subject is, however, very incomplete.

In the species of Hylidae coloration may be distributed into two regions; the first including that which is exposed to the light when the animal is crouched, with the limbs all flexed and close pressed to the sides, the hands and feet concealed more or less under the body; and the second embraces what is thus hidden from the light, especially the portions in actual contact in flexure. Any marked difference in color of the different surfaces will usually be found to have reference to this division into regions, generally very dissimilar in appearance. This is well seen in *Hyla andersonii*, *carolinensis*, and in Phyllomedusa and Agalychnis. For convenience of reference, I here, as in other genera of Batrachia Salientia, term the portions of the body and limbs which are exposed to the light external; those concealed in the flexure, internal.

ACRIS Duméril and Bibron.

Erp. Gén., VIII, 506; Günther, Cat. Batr. Sal. Brit. Mus., I ed., 1856, p. 71; Cope, Nat. Hist. Rev., 1865, p. 110; Cope, Journ. Ac. Phila. (2), VI, 1866, 86; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, II ed., p. 336.

But one species of this genus is known, and it is found throughout the greater part of the North American realm. It is quite possible that it may become necessary at some future time to unite this genus with Hyla.

ACRIS GRYLLUS Le Conte.*

Dum. & Bibr. Erp. Gén., VIII, 507; Le Conte, Proceed. Ac. Phila., 1855, 28; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, 336.

Rana gryllus Le Conte, Ann. Lyceum New York, I 1825, p. 282; Harlan, Med. Phys. Res., p. 104.

Rana dorsalis Harlan, *l. c.*, p. 105.

Hylodes gryllus Holbr., N. Amer. Herp., Pl. 33.

Head moderate, length to canthus oris equal breadth at same point. Muzzle narrowed, produced; profile projecting or nearly perpendicular. Canthus rostralis weak, approximate; external nostril little nearer edge of lip than to orbit. Vertex plane; diameter of orbit greater than interorbital breadth, three times in length from end of muzzle to posterior border of tympanic membrane. Latter indistinct; partially obscured by a fold one-fifth the size of the orbit. Skin of head and body above with rather distant tubercles, of which some on the scapular regions are more or less pliciform. No areolation on thoracic and gular region. A series of small tubercles on the outer border of the tarsus; two small metatarsal tubercles. Articular tubercles of the phalanges very small.

*Plate 73, fig. 29.

Tongue broad, obovate, sometimes nearly ovate, distinctly to not emarginate posteriorly. Vomerine teeth in two ovate patches between the interior nares, as near them as to each other.

The end of the fore-arm extended reaches the external nares. The heel of the extended hind leg reaches to or beyond the end of the muzzle. Two large metacarpal tubercles. Length of head to tympanum, one-third that of head and body.

Average size: Length of body, 12 lines; from vent to outer end of femur, 6 lines; tibia, 7 lines; tarsus and foot, 9 lines.

Typical coloration: Above, brown or gray, with a blackish triangular patch between the eyes, the apex directed backwards; the borders of this are of a light color, which is light green in life, and is continued as a band to the end of the body. Three dark bars on the lip, one from the eye to the anterior upper arm across the angle of the mouth, pale bordered above. A dark bar from the orbit across the tympanum, and one from scapular region to beyond middle of side. A dark bar from behind the scapular region restricts the dorsal line near the sacrum, and is usually continued with an interruption to the groin. Color of upper surfaces continued on a less part of surface of femur, which is cross-barred; behind this pale, with a longitudinal band or series of spots posteriorly. Throat in spring yellow.

This species possesses the power of metachrosis or color-change in a high degree. The dorsal stripe and border of the interocular spot may be bright green, dirty white, or bright rusty; and the dorsal tubercles vary in color in the same way. The general tint varies from bright green to dull slate color.

In its habits the *Acris gryllus* is a lover of the muddy borders of the water, into which it leaps when alarmed. As it does not conceal itself among vegetation, like the *Hyla pickeringii*, it is much more easily caught than that species, and is more common in museums, though not less abundant. As the structure of the feet indicate, it is a good swimmer, and its powers of leaping are remarkable.

This species is distributed from Florida to Texas, through Kansas and the Northwest to the Atlantic, and as far northeastwardly as New York.

The northern and southern sections of this area produce forms which offer considerable differences, but which must be termed subspecies, on account of the existence in some localities of intermediate individuals. I have seen such from Illinois, Pennsylvania, Missouri, and elsewhere.

These subspecies are as follows:

Hinder foot less tarsus less than half the length of the head and body; dermal tubercles larger; posterior femoral stripe less distinct ..... *A. g. crepitans.*

Hinder foot less tarsus longer than half head and body; dermal tubercles smaller; femoral stripe very distinct ..... *A. g. gryllus.*

These subspecies are respectively of northern and southern distribution; the *A. g. gryllus* ranging from North Carolina to Florida and Louisiana.

Acris gryllus crepitans Baird.

Acris gryllus Dum. & Bibr., Erp. Gén., VIII, 1841, p. 506, *partim;* Günther Cat. Batr. Sal. Brit. Mus., 1858, p. 7, *partim.*

Hylodes gryllus De Kay, N. Y. Zool., Reptil., III, 1842, p. 70, Pl. XXII, fig. 61.

Acris crepitans Baird, Proceed. Ac. Phila., 1855, p. 59; Le Conte, *l. c.*, p. 426; Baird, U. S. Mex. Bound. Surv., Rept., p. 28, Pl. XXXVII, fig. 14–17.

FIG. 82. *Acris gryllus crepitans.* No. 13924. Des Moines, Iowa, $\frac{1}{1}$; 6 and 7, $\frac{2}{1}$.

Brownish above. The median region of head and body above bright green; a dark triangle between the eyes. Three oblique blotches on the sides, nearly equidistant: the first behind the eye, the last on the flanks and running up on the back; all usually margined with lighter, a narrow white line from the eye to arm. Beneath yellowish-white. Inferior face of thigh plain. Tibia a little more than half the length of the body. Foot rather smaller. Head rather obtuse, scarcely longer than broad. Web of hind foot extending to the penultimate articulation of the fourth toe.

This subspecies is characterized by a rather long, narrow head, with the eyes farther back than usual. There is no constriction for the neck, the outline tapering towards the snout from about the middle of the body. The limbs are very muscular, and considerably developed.

The eyes are large and prominent; their anterior edges decidedly behind the middle of the commissure, and their posterior barely anterior to the angle of the mouth; hence the snout is considerably produced. The nostrils are minute, situated on the canthus rostralis, rather nearer the tip of the snout than the eye, and separated by a distance less than one-third the width of the rami. The tympanum is small, not very distinct, about half the diameter of the eye, and placed just above the rictus. The head is almost as long as wide, especially in large specimens.

The tongue is broad, oval, subtruncate, and but slightly emarginate behind; the anterior extremity rounded; it is free behind and on the sides. The inner nares are large, open, placed a little in front of a point opposite the anterior canthus orbitalis.

The vomerine teeth are situated in two oval patches about the size of the nares, the slightly longer axes inclined a little to each other, backward. They are placed between the nares, their anterior edges nearly in the same transverse line with those of the nares, and extending a little beyond the nares posteriorly, and thus more anterior than in any other of the small Hyloids of North America. They are about as

far apart posteriorly as their anterior extremities are from the nares. The Eustachian apertures very minute, less than the inner nares.

The lower parts are covered by a depressed pavement or granulation, extending half-way up the side and on the inferior face of the thighs In many specimens this appears to be wanting between and anterior to the arms. The upper parts generally are provided with rather scattered pustulations or warty elevations, with numerous pores opening between and on them; these pustules are most numerous on the sides and anteriorly. Some are considerably larger and longitudinal, and appear most distinct near the edges of the vertebral vitta.

The hands are large and well developed; rather longer than the forearm. The tips of the fingers and toes are provided with very slightly enlarged, depressed pallets or disks, convex beneath and with a nail-like groove.

The outer finger is rather longer than the second, and all appear to be connected by a very slight thickened membrane. The inner finger is set at a right-angle with the third and posterior to the rest. There is a soft large tubercle at its base, and a still larger opposite to it on the other side of the palm, the two with only a narrow interval. All the articulations of the fingers and toes have well-developed tubercles between them.

The femur is shorter than the tibia, rather longer than the foot; the tibia is more than half the length of the body. The two outer metatarsi are firmly united, the others cleft to the base; the intervals of the latter, however, filled up by a well-developed membrane, which extends as far as the bases of the disks, and filling up most of the space between the toes, except on each side of the longest, where the membrane forms a narrow margin on the penultimate joint. The third toe is a little longer than the fifth or outer. The cuneiform process makes a considerable prominence, while on the opposite or outer side of the tarsus and foot are three or four small tubercles, at about equal distances, the distal one opposite the cuneiform process and largest. The tubercles beneath the articulations are very distinct. There is a rudimentary membrane along the exterior edge of the foot.

In alcohol the general color above is of a dull brown. During life, however, an area bounded by lines extending from the nostrils and diverging to the middle of the edge of the upper eyelid, then converging to the sacral vertebra, then again widening to the buttocks, is of a bright grass green. This is interrupted between the eyes by a well-defined triangle of brown, nearly equilateral, with rather concave sides, and its base connecting the edges of the upper eyelids. A dusky line extends along the canthus rostralis. The sides of the face and edges of the upper jaw exhibit three or four indistinct square blotches, separated by narrower intervals; one or more sometimes better defined than the rest. A dark broad line extends from the sides of the lower jaw to the lower part of the insertion of the arm, and another from the posterior

portion of the orbit to the upper edge of the same insertion; the two are oblique and parallel. They are separated by a narrow light (even white) line, extending from the orbit a little behind the lowest part and running to the middle of the insertion of the arm. Behind the arm and on the side of the body is a still larger blotch, similar and parallel to the last mentioned, and behind this and higher up on the back still another, anteriorly covering the loins on each side, and running obliquely backwards so as to be parallel to the others. The blotches of this posterior pair are separated by the narrowest part of the green stripe, which is bounded to a considerable distance by these blotches. All the blotches just described, as well as that on the top of the head, are dark brown, margined by a lighter areola, which on the sides and back is sometimes yellowish in life. The under parts are yellowish-white or pure white; the throat sometimes bright yellow; sometimes closely or sparsely crowded with dark spots. There are no well-defined darker blotches on the arm; but the thigh, leg, tarsus, and foot each exhibit two or three transverse ones. The buttocks are yellowish, with the arms brown, and the posterior and anterior faces, with small blotches, some of which are occasionally confluent into an irregular dark line along the anterior and posterior faces of the thigh. The granulation about the buttocks is usually white.

A specimen from Russellville, Ky., has the blotches much smaller than usual.

In a specimen from Carlisle the last vertebra has the transverse apophyses very little dilated, though somewhat enlarged at the ends.

	Inches.			Inches.	
Total length	1.08	1.00	Tarsus	.28	.25
Arm and hand	.40	.37	Foot	.49	.45
Hand alone	.27	.25	Total of leg stretched	1.76	1.63
Thigh	.53	.47	Width of head	.36	.33
Leg	.58	.54	Chord of upper jaw	.38	.35

The iris of this subspecies is golden and capable of excessive contraction. A broad blackish spot occupies it at each end of the pupil, and a narrow black line above and below the latter. When the iris is contracted the pupil is shortly transverse, not linear as in many Hylæ, and the brown spots are triangles, their apices inwards.

Specimens from the lower Mississippi are frequently of obscure colors, of rather larger size, and with large tubercles. I have not been able to distinguish them as forming a constant subspecies. Mr. Boulenger, (Catal. Batr. Sal., Brit. Mus., 1882, p. 337) refers such a specimen to a "var. bufonia."

In connection with metachrosis in this species I observed in a specimen lately dead that on the end of the muzzle, palpebræ, canthus rostralis, outer line of humerus, ends of sacral diapophyses, where the derm was in a state of tension, that it assumed a bright green hue.

The note of this species may be exactly imitated by striking two marbles together first slowly, then faster and faster, for a succession of

about twenty or thirty beats. The noise can not be heard at a very great distance. Like *Hyla pickeringii*, this species in confinement can readily be made to produce its note by imitating it, either with the voice or the clattering of two pebbles. It keeps on the high grass in and around marshy places, seldom if ever ascending trees or bushes. When pursued it leaps with prodigious agility and hides under water.

Acris gryllus gryllus Le C.

Rana gryllus Le Conte, Ann. N. Y. Lyc. I (1825), 282; Harlan, Journ. Ac. Nat. Sci. V, (1827), 317, and Med. and Phys. Res. (1835), 104 (copied).

Rana dorsalis Harl., Journ. Ac. Nat. Sci., Phila. V (1827), 317, and Med. and Phys. Res. (1835), 105 (Fig. on p. 72), (Florida.)

Hylodes gryllus Holbrook, N. Amer. Herp., 1st ed., II (1838), 75, XIII, and 2d ed., IV (1842), 131, XXXIII, *partim.*

Acris gryllus Dum. & Bibr., Erp. Gén., VIII (1841), 506; Aug. Dum., Ann. Des. Sc. Nat., 3me serie, XIX (1853), 153; Günther, Cat. Brit. Mus., 1858, p. 71, *partim;* Boulenger, Cat. Brit. Mus., II ed., 1882, p. 336.

Acris acheta Baird, Proceed. Ac. Phila., 1855, p. 59.

Body slender; head pointed. Limbs much elongated. Head longer than wide. Web of hind foot extending only to the third articulation (from tip) of longest toe. Tibia two-thirds length of body. Foot more than half length of body. Colors much as in *A. crepitans*, but brighter. Inferior surface of thigh plain, or very slightly freckled with darker. A narrow white line from eye to arm and a light line above the urostyle.

Having presented a minute description of *A. crepitans*, it will only be necessary here to give the principal points of difference as compared with that species. The entire form is much more slender, and the limbs longer in proportion. The head is much more acute, and the outline of the lower jaw elliptical, instead of being nearly semicircular. The chord of the rami is longer than their greatest width, not equal to it, and the cleft extends further back. The tympanum in both is scarcely distinguishable. The tongue is large, triangular, and fleshy. The teeth are in two small circular patches, between the inner nares, and separated by quite an interval. The pallets at the tips of the more elongated fingers and toes are very moderate, less prominent than in *A. crepitans.* The fourth or longest toe projects beyond the rest much more than in *A. crepitans* and the web scarcely extends on either side beyond its antepenultimate articulation, while in *A. crepitans* this web reaches to the penultimate one and even as a very narrow margin to the very tip; nor between any of the phalanges does the membrane extend to the disks as in the other.

The general distribution of color is the same, although the pattern is brighter and clearer. All the blotches have a narrow border of white. The posterior large one seems to extend higher up on the back. The upper jaw has four narrow white lines perpendicular to its edge on each side, as in the other species, inclosing nearly equal spaces. There is a light streak down the posterior part of the back above the urostyle which we have not noticed in the other. The dark longitudinal line on the

posterior face of the thigh is more distinct. The limbs are more finely barred above, three or four fasciæ on each joint; the upper and outer surface of the hands and feet also finely barred.

The skin above seems rather smoother than in the other, while the throat is more granulated.

As regards the transition between this subspecies and the *A. g. crepitans*, a number of specimens display intermediate proportions. Thus in some the posterior foot, minus the tarsus, is exactly half the length of the head and body. In some lots from a single locality some specimens have the hind foot one-half the length, while others fall a little below, and still others fall a little above this proportion. Such a lot is that from Cooper County, Mo., No. 3557.

The distinctness of the posterior femoral brown stripe is subject to variation. In typical *A. g. gryllus* it is sharp, and is bordered above and below by pale bands, of which the latter is again bordered below by a darker shade. In other specimens the lower pale band is shaded, and its inferior brown edge is indistinct. The inferior edge of the brown band becomes irregular, and in the *A. g. crepitans* it is a good deal interrupted by paler.

Acris gryllus crepitans Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3553	4	Oconomowoc River, Wis.		Prof. S. F. Baird	Alcoholic.
3556	2	do		A. C. Barry	Do.
3274	1	Fort Inge, Tex		Dr. C. B. R. Kennerly	Do.
3278	1	do		do	Do.
3268	1	New Braunfels, Tex		F. Lindheimer	Do.
3265	1	Indianola, Tex		J. H. Clark	Do.
3555	3	Russellville, Ky		Bibb	Do.
3585	5	Prairie Mer Rouge, La		James Fairie	Do.
3279	1	Fort Smith, Ark		Dr. B. F. Shumard	Do.
3552	2	Aztalan, Wis		Prof. S. F. Baird	Do.
4899	2	Washington, D. C		Dr. Wm. Stimpson	Do.
3551	1	Carlisle, Pa		Prof. S. F. Baird	Do.
3266	2	Verdigris River		J. H. Clark	Do.
3264	5	North Platte, Nebr		W. S. Wood	Do.
3273	9	South Fork		Dr. F. V. Hayden	Do.
3275	6	105 miles west of Fort Riley, Kans.		W. S. Wood	Do.
3269	3	Republican River, Mo		Dr. W. A. Hammond, U. S. A.	Do.
3280	1	Rock Marcy		H. B. Mollhausen	Do.
3575	6	Saint Louis, Mo		Dr. G. Engelmann	Do.
3565	3	Mason County, Ill		R. Kennicott	Do.
3568	4	South Grand River, Miss		Dr. P. R. Hoy	Do.
4909	2	Kansas		Dr. J. G. Cooper	Do.
8871	1	Tickfaw, La	Dec. 26, 1876	Dr. T. H. Bean	Do.
8344	8	Goldsborough, N. C		J. W. Milner	Do.
8178	50	Union County, Ill		R. Kennicott	Do.
11930	2	Swampson Loup Fork		Dr. F. V. Hayden	Do.
3550	15	Carlisle, Pa		Prof. S. F. Baird	Do.
3560	12	New Madrid, Mo		R. Kennicott	Do.
9415	2	Waukegan, Ill		J. W. Milner	Do.
7827	9	Washington, D. C		Dr. E. Coues	Do.
11480	3	(?)		(?)	Do.
1109	2	Pensacola, Fla		Dr. J. Hammond	Do.

GENERAL SERIES.

3271	1	Loup Fork	Lieut. G. Warren, U. S. A.	Alcoholic.
3566	1	Saint Louis, Mo	Dr. G. Engelmann	Do.
3277	3	Fort Riley, Kans	Lieut. F. T. Bryan, U. S. A.	Do.

Specimens intermediate between A. g. gryllus and A. g. crepitans.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3562	14	Grand Detour, La		P. L. Hoy	Alcoholic.
3557	15	Cooper County, Mo		do	Do.
13328	20	Washington, D. C		George Shoemaker	Do.
12073	2	Mount Carmel, Ill		L. M. Turner	Do.
11913	3	Nashville, Ga		W. J. Taylor	Do.
12707	2	Lookout Mountain, Tenn		W. F. Foe	Do.
12570	4	Willoughby Point, Va		Earll and McDonald	Do.
3579	2	Mobile, Ala		Pilichody	Do.
11835	3	Old Fort Cobb, Cal		Dr. E. Palmer	Do.

Acris gryllus gryllus Le Conte.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3558	1	Pensacola, Fla		Dr. J. P. Hammond, U. S. A.	Alcoholic.
3560	6	New Madrid, Mo		R. Kennicott	Do.
3561	7	Charleston, S. C		Dr. C. Girard	Do.
3564	5	Georgia		Dr. J. L. Le Conte	Do.
5909	7	do		do	Do.
3567	6	Salem, N. C		J. T. Lineback	Do.
9464	1	Southern Illinois		R. Kennicott	Do.
9696	3	Arlington, Fla		G. Brown Goode	Do.
3935	3	Dayton, Ala		Edgeworth	Do.
3585	4	Prairie Mer Rouge, La		James Fairie	Do.
11395	2	Milton, Fla		S. T. Walker	Do.
4899	3	Washington, D. C		William Stimpson, M. D.	Do.
12076	1	Mount Carmel, Ill		L. M. Turner	Do.
11912	5	Nashville, Ga		W. J. Taylor	Do.

CHOROPHILUS Baird.

Proceed. Ac. Phila., 1854, p. 59; Cope, Journal Acad. Phila., 1886, p. 86.

Helœcetes Baird, Proceed. Acad. Phila., 1854, p. 59

Pseudacris Fitz., Systema Reptilium, 1843, 31 (no character); Günther, Cat. Batr. Sal. Brit. Mus., 1858, 97; Cope, Nat. Hist. Rev., 1865, 110.

Cranium flattened; a large frontoparietal fontanelle. Prefrontals elongate, divergent, not in contact anteriorly, extending beyond the extremity of the well-developed prolonged superior ethmoid plate. Tongue rounded or elongate, slightly emarginate behind, where it is free for about half its length. Inferior eyelid transparent. Males with subgular vocal vesicle. Xiphisternum fibrocartilaginous; sometimes cartilaginous, flattened, elongate. Digits free except in some a slight web connecting free portion of metatarsals; dilatations small or wanting, the phalange with the claw strong, and the ball not emarginate. Dilatations of sacral diapophyses nearly equilateral.

In the known species the vomerine teeth are present in two small approximated patches behind the point exactly between the nares, and the tympanum is distinct.

This genus is nearly related to that group of the species of Hyla named Litoria in the Erpetologie Générale. From typical forms of

the former, the ethmoid plate without supraorbital angles, the elongate terminal phalanges with small basal globe, supporting minute dilatations, and the nearly webless digits distinguish it. Species of Hyla less representative are similar in cranial structure, and have a diminished amount of palmation, but the series appears with our present knowledge distinct in the structure of the feet. Like the Litorias, its life is passed on the ground, and chiefly in the neighborhood of small pools in open and barren situations, where the voices of the species may be heard with the Acris in the summer, long after the Hylas have sought their leafy retreats in the wood or fence row. They differ from the first-mentioned genus in being poor swimmers; though they leap into the water when alarmed, they do not swim far from the shore, and soon return to it. They do not seem to be possessed of the power of making such enormous leaps as the Litorias of Australia, or even as our Acris. In typical Litoria the brain case is more elongate and cylindrical and the frontoparietal fontanelle much narrower, but in *L. americana* the form and proportions are the same.

The general form and habits of the Australian genus Crinia are not very different from the present; the terminal, not inferior, attachment of the ultimate phalanx will separate it from all Hylidæ.

Chorophilus is distributed from the Rio Grande, Salt Lake Valley, and Rocky Mountains on the west, to the Atlantic, and from the Gulf to the northern limits of the United States west of the Alleghanies; east of this range I am not aware of its occurring north of middle Pennsylvania. Of its six species four are confined to the Gulf States and South Carolina, while the fifth is found under several forms throughout the whole of the north and southwest, the northern and middle parts of the central, and the middle of the eastern region to Pennsylvania and New Jersey.

The species differ as follows:

I. Muzzle rounded in profile, projecting.

a. Skin of upper surfaces smooth.

Stout, width of head at tympana entering total length 2.5 to 2.66 times; nostril half-way between muzzle and orbit; posterior foot shorter, slightly webbed, and with subarticular tubercles; heel reaching tympanum ..... *C. ornatus.*

More slender; width of head entering length 3 to 3.5 times; nostril nearer end of muzzle than orbit; posterior foot longer, not webbed, and without subarticular tubercles; heel reaching middle of orbit..... *C. occidentalis.*

aa. Skin warty above.

Head acuminate, the width entering the total three times; heel reaching anterior to orbit; size larger..... *C. nigritus*

Head short, wider; the width entering the length 3.25 times; the heel reaches to the front of the orbit; small ..... *C. feriarum.*

Head acuminate; the width entering the total 3.5 to 3.66 times; hind legs short; heel reaching posterior border of membranum tympani ..... *C. triseriatus.*

II. Muzzle truncate in profile.

Vertex and front plane; canthus rostralis sharp; hind legs long.. *C. ocularis.*

CHOROPHILUS ORNATUS Holbrook.*

Cystignathus ornatus Holbr., N. Amer. Herp., IV, p. 105, Pl. 25.
Chorophilus ornatus Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 333.
Chorophilus ocularis Daudin, Cope, Bull. U. S. Nat. Mus., No. 17, 1880, p. 27.

Muzzle and canthus rostralis rounded; the former projecting, but short, not longer than diameter of eye; external nares nearer the orbit than the end of the muzzle; skin not areolated or roughened above; toes without terminal knobs, distinctly webbed at the base, and with well-developed subarticular tubercles; hind legs short, heel only reaching posterior edge of tympanum when extended.

The head is rather short, and the anterior outline is a narrow oval. The extremity of the muzzle projects beyond the mouth, and the lores are slightly oblique and a little concave. The nostril is but little nearer the extremity of the muzzle than the orbit. The vertical diameter of the tympanum a little exceeds the transverse, which is one-half the long diameter of the eye-slit. The pupil, as in the other species of this genus, is horizontal. The tongue is wide, discoid, and entire behind. The ostia pharyngea are smaller than the small choanæ. The vomerine patches are short and transverse; they are entirely within the lines of the inner borders of the choanæ and behind the line of the posterior borders of the same.

The tubercles of the superior surfaces are small and rather closely placed; they are largest on the sides of the back. There is a faint areolation of the gular region. The limbs are short and stout. The humerus is half or more inclosed in the skin. The palm reaches nearly to the end of the muzzle. The fingers are short and stout, and have neither dilatations nor borders. The first is shorter than the second, which equals the fourth. The palmar tubercles are not distinct. The heel of the appressed hind foot in thin specimens marks the middle of the tympanic disk or posterior border of orbit, and the end of the muzzle the extremity of the tarsus. The hind foot beyond the tarsus is only as long as the tibia. The toes have no dilatations, but possess dermal margins, and a short but distinct basal web. There is but one solar tubercle, a small cuneiform prominence. Total length, .035^{m}; of head, to line of posterior borders of membranum tympani, .011^{m}; width of head at the latter, .014^{m}; length of hind leg, .045^{m}; of femur, .013^{m}; of hind foot, .022^{m}; of tarsus, .009^{m}.

The color above is olive-gray, and below uniform straw-color. A black band passes from the end of the muzzle on each side, through the eye, and, expanding over the ear-drum, terminates in front of the humerus. One or two dark spots above and behind the axilla may unite to form part of a lateral band. There may or may not be blackish spots above the groin and on the pelvic region and anterior part of the back.

* Plate 72, fig. 2.

The limbs have a few dark-brown cross-bands; the femur is yellowish and unspotted behind.

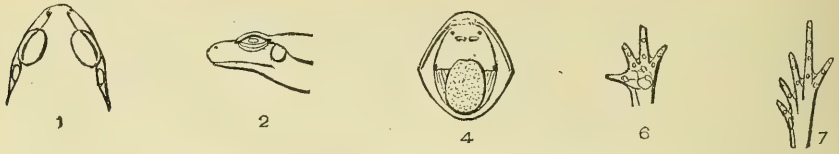


FIG. 83. *Chorophilus ornatus*. No. 13634. Helotes, Texas; ½.

Dr. Holbrook describes the colors of this species in life as follows:

Dove-color above, with oblong spots of dark-brown, margined with yellow.

The head has a broad, indistinct, triangular spot between the orbits, the apex of which is directed backwards. A black line extends from the snout to the orbit of the eye, including the nostrils; below this black line is a yellowish blotch, covering most of the upper jaw. The lower jaw is cinereous above and white below. The pupil is very dark, the iris of a golden color. The tympanum is very dark colored, and placed in a dark vitta, or blotch, which extends from behind the orbit to within a short distance of the shoulder. The body is of a delicate dove-color above, with two or more oblong spots of dark brown, margined with yellow, on each side of the vertebral line; below these, and on each flank, are three smaller spots, likewise margined with bright yellow, the anterior one being the largest; these, with a smaller one above the vent, form a triangle on each flank; several bright yellow spots, also disposed in a triangular form, with the apices directed forwards, are concealed by the thighs. The inferior surface of this animal is silver-white, and except on the throat, everywhere granulated; about the throat are a few indistinct points of black; the anterior and middle parts of the abdomen are white with a slight tinge; the posterior third approaches to flesh-color.

The anterior extremities are dove-colored above, with a few distinct dark bands placed transversely on the fore-arm, and a black spot at the elbow; a black line runs from the inferior and upper part of the shoulder towards the lower jaw; dove-colored above, with transverse bands of dark brown; on the anterior part of the thigh are several small yellow spots; on the posterior surface these spots are numerous and so closely approximated as to resemble at first view a yellow waving line. The whole under surface of the thighs is flesh-colored; the inferior surface of the legs is also flesh-colored, with a few yellow dots.

No. 13634; one specimen; Helotes; Bexar County, Texas; G. W. Marnock.

Other specimens of this species are in my private collection from the same locality, and from Dallas, Texas.

CHOROPHILUS OCCIDENTALIS Bd. & Gird.

Litoria occidentalis Bd. & Gird., Proceed. Ac. Phila., 1853, p. 301.
Cystignathus ornatus "Holbr.", Günther, Cat. Batr. Sal. Brit. Mus., ed., 1858, p. 29; *nec* Holbrookii.
Chorophilus ocularis Cope. Check-List N, Amer. Bat., Reptil., 1875, p. 30; *nec Hyla ocularis* Daudin.
Chorophilus copii Boulenger, Cat. Batr., Sal. Brit. Mus., ed. II, 1882, p. 334.

Head rather acute. Tibia reaching half-way from the anus to the nostrils. Above, chestnut with obsolete blotches of darker. A dark chestnut stripe from snout through eye and tympanum, with several large oblique blotches of the same on the sides. Beneath, reddish-white; immaculate.

Proportions rather slender and graceful. Head rather acute; no perceptible contraction at the neck; legs long and much developed.

The nostrils are situated very near the tip of the snout (the sides of which are rather abrupt); they are separated from each other by less than one-third the width of the head. The eyes are moderate, the tympanum small, about half the diameter of the orbit. A groove passes from the posterior portion of orbit above and around the tympanum to the insertion of the arm in front. Anterior margin of the eyes about opposite the middle of the commissure. Tongue variable in different specimens; in one (a male) large, and filling up the interspace of lower jaw; the edges thin and free behind and laterally; broadly or orbicularly cordiform. In two others the tongue is contracted into smaller space, thus thickening the edges, although still retaining much the same shape. The inner nostrils are large, opposite to the anterior canthus of the orbit. The vomerine protuberances are in two elliptical patches, their longer axes in the same transverse line; their anterior edges just behind the posterior border of the nostrils; the two separated by a narrow interval. One specimen has the patches more elongated, and narrower than the two others.

The head is slightly shorter than broad. The fore-arm is longer than the hand; the tibia, about half the length of the body, is longer than the thigh, and about the length of the foot.

The fingers and toes are all slender, cylindrical, and tapering slightly to the delicate tips, which present no indications of pallets. The fingers are entirely free; the outer longer than the second, the third longest. The two external metatarsals are united to the end, with no web between them. The other metatarsals are divided to the tarsus, but connected by a web of considerable development, which scarcely passes beyond the ends of the metatarsus. The outer toe is longer than the third. Transverse apophyses of sacral vertebra dilated, with triangular pallet.

The under parts, anterior to the slight pectoral fold, are entirely smooth. Behind this is a pavement of depressed granules, which extends to the inferior and posterior surface of the thighs, becoming finer

posteriorly; they also pass up the sides, becoming less and less distinct. The upper parts appear entirely smooth, except an occasional and isolated pustule on the side of the back.

The general color above is of a light chestnut, with blotches of dark chestnut; beneath, reddish-white. A dark chestnut line extends from the snout through the nostril to the anterior canthus, and re-appears behind the eye in an oval patch, involving the whole tympanum, and extending above the shoulder. A second similar patch appears on the side, separated from the first by about the thickness of the arm. Behind this again, and a little more on the back, is a smaller blotch, behind which is one still smaller, and the region of the anus is tinged with the same color; there thus appears to be a chain of these blotches, extending, at about equal distances, from the anus to the eye, the two last-mentioned lateral ones fully visible from above. There are indistinct indications of darker blotches on the back, and suffusions of the same round the scattered pustules referred to. The extreme edge of the upper jaw is dark, but between this and the upper stripe, involving nearly the whole side of the face below the eye, is an area of light chestnut, becoming clearer and brighter under the eye. A chestnut stripe extends from the lower jaw up the arm, which has, besides, two or three transverse blotches; the femur, tibia and tarsus have each two or three transverse fasciæ. The anterior face of the thighs is light chestnut; the buttocks the same, with indistinct blotches of lighter. In some specimens the ground color is greenish lead color.

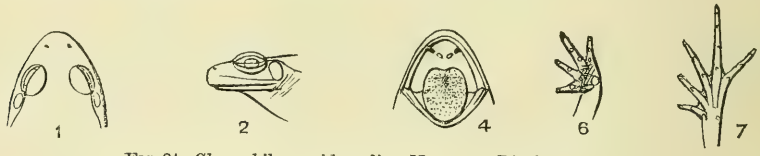


FIG. 84. *Chorophilus occidentalis*. No. 5905. Riceboro, Ga.; ½.

Measurements, in inches.

Total length	1.04	1.00	Total hind leg, stretched	1.80	1.73
Femur	.48	.46	Fore-arm to tip	.52	.50
Tibia	.51	.49	Width of head	.40	.38
Hind foot	.48	.46	Chord of ramus	.40	.38
Tarsus	.34	.33			

From the *C. ornatus* the *C. occidentalis* differs in color entirely; the head is more acute, and the cleft of mouth deeper; the legs are longer and the granulation finer.

This species is quite distinct from the *C. ornatus*, and does not appear to have been named by any European author prior to Boulenger. My identification of it with the *Hyla ocularis* of Daudin was based on a plate representing it, or a species very similar to it, in one of the older authors, but for which I have lost the reference. As pointed out by Boulenger, it is clearly not the species so called by Daudin.

The *Chorophilus occidentalis* ranges from Georgia to the Wichita River, in north central Texas. Specimens were sent me from the latter locality by that excellent naturalist, Jacob Boll, of Dallas. Dr. A. K. Fisher has found it near Jacksonville, Florida. It does not occur in California as supposed when first described.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3590	2	Georgia		Maj. J. Le Conte	Alcoholic.
5905	1	Riceborough, Ga		do	Do.
5906	2	do		do	Do.
3584	1	Liberty County, Ga		do	Do.
	2	Allapaha, Ga		W. J. Taylor	Do.

CHOROPHILUS NIGRITUS Le Conte.

Rana nigrita Le Conte, Ann. Lyc. N. Y., I, p. 282; Harlan, Med. & Phys. Res., p. 105; and Journ. Ac. Phila., V, p. 341.
Acris nigrita Dum. & Bibr., p. 509.
Cystignathus nigritus Holb., N. Amer. Herp., IV, p. 107, Pl. 26.
Pseudacris nigrita, pars, Günth. Cat., p. 97.
Chorophilus nigritus Baird, Proc. Ac. Phila., VII, p. 60; Le Conte, *eod. loc.*, p. 427; Boulenger, Cat. Batr. Sal., p. 333.

The length of the head to the posterior margin of the membranum tympani enters the total length to the vent three and one-sixth times. The head itself is narrow and acuminate, the muzzle projecting acutely beyond the labial margin. The external nares mark two-fifths the distance from the end of the muzzle to the orbital border. The membranum tympani is only one-fourth the diameter of the orbit. The canthus rostralis is distinct, but obtusely rounded. The vomerine fasciculi are approximated, and near the line of the posterior border of the nares, which are larger than the minute ostia pharyngea. The tongue is large and wide behind, and faintly emarginate.

The heel of the extended hind leg extends to between the orbit and nostril; the femur is short, while the tarsus is long, a little exceeding half the length of the tibia, and equaling the length of the remainder of the foot, minus the longest toe. The skin of the gular and sternal region is smooth, of the abdomen areolate. That of the dorsal region is tubercular, smooth warts of large and small size being irregularly crowded over its entire surface, and not at all resembling the areolate surface of the belly.

Color above leaden, with three longitudinal rows of darker, light-edged spots, extending one on each side, and one on the median line. These spots may be united into a band on one or on both sides or on the middle line. Thigh with three cross-bands, unicolor behind; tibia with from three to five cross-bars. Upper lip dark plumbeous, with a narrow white line above a darker border, which extends a little beyond below

the tympanum. The dark band from the end of the muzzle extends to the middle of the side, or beyond. Inferior surfaces yellowish.

FIG. 85. *Chorophilus nigritus.* No. 5935. Liberty County, Ga.; 1–4, ½; 6–7, ¾.

Measurements of No. 5935.

	M.
Length of head and body	.030
Length of head, including tympana	.0105
Width of head, including tympana	.0095
Length of fore-leg	.0165
Length of fore-foot	.006
Length of hind leg	.0475
Length of tibia	.0145
Length of tarsus	.0094
Length of remainder of foot	.0145

This species is rare in collections and has not been well identified, owing to the imperfection of Dr. Holbrook's description. It can be best recognized from Le Conte's description above quoted. It is an evident ally of *C. triseriatus.*

A small form is found in Florida, which I have described under the name of *Chorophilus verrucosus.* It differs somewhat from the typical Nigricans, and I suspect that it will turn out to be a subspecies. It differs, besides its very small size, in the somewhat longer tarsus, which exceeds the foot minus the fourth toe, in length. The yellow stripe on the upper lip is broken up into a series of spots. The measurements are as follows:

	M.		M.
Length of head and body	.019	Length of tibia	.008
Length of head	.006	Length of tarsus	.005
Length of hind limb	.026	Width of head at tympana	.0055
Length of femur	.007		

From Volusia, Fla.; Mrs. A. D. Lungren.

This Chorophilus is similar in proportions to the *C feriarum*, but is well distinguished by the characters of the longer hind leg, the skin, and the coloration. The tubercular upper surface is quite peculiar, and the smooth gular region is equally wanting in the Northern frog.

Chorophilus nigritus Le Conte.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
9702	2	Arlington, Fla		G. Brown Goode	Alcoholic.
5935	2	Liberty County, Ga		Dr. J. L. Le Conte	Do.
3593	5	Charleston, S. C		Dr. S. B. Barker	Do.

CHOROPHILUS FERIARUM Baird.

Helœcetes feriarum Baird, Proceed. Ac. Nat. Sci. Phila., 1854 (5), 59.

This species is not unlike a young *Hyla versicolor* in the short and rather squat form. The head is more pointed, however, the curve of the mouth being parabolic rather than circular. The outline of the head above exhibits an acute angle, with but a very slight curve to near the nostrils. The sides of the head are quite oblique, and the direct distance between the two anterior canthi, as measured with the dividers, is just half that between the two extremities of the lower jaw, measured in a similar manner. The upper jaw projects considerably over the under; so much so that the nostrils are about directly over the end of the latter. The extreme distance between the rami of the lower jaw is the same with that from the ends of these rami to the tip of the snout, thus forming of the three lines an equilateral triangle. The tympanum is quite diminutive, scarcely more than half the diameter of the eye; certainly not over half the straight edge of the eyelids. In the females it is still smaller. Its center is situated directly over the angle of the mouth or the rictus.

The tongue is large, thin at the edges; about one-fifth longer than broad, and cordiform behind, with the sides but slightly curved; free behind for about one-third its length. The posterior nares are nearly circular and opposite a point half-way between the anterior canthus of the eye and the outer nostril. The vomerine teeth are in two oval patches, their axes inclined backwards at less than a right angle, the anterior extremities commencing just inside the posterior nares and on a line with their centers.

The males are provided with a very prominent gular pouch, capable of considerable inflation.

The eyes are of moderate size, being a little more than one-third the distance from the angle of the mouth to the tip of the snout.

The limbs are of moderate development; the fore-arm being less than the hand. The arm from the elbow is exactly the length of the hind foot, measured from the end of the tarsus. The femur and tibia are equal and just half the length of the body. Closely pressed along the sides, the tips of the hind toes extend nearly to the tympanum. The

toes are all depressed, rather sharp along the edges, slender, with parallel sides, and not fringed. All are terminated by slight knobs, not pallets, but little if any wider than the fingers, and very faint traces of the marginal nail-like groove. The hands are not webbed, except a very slight basal web between the three outer fingers. The toes have their bases very slightly webbed, the membrane filling up the spaces between the metatarsals of the two outer toes. The tubercle at the base of the inner toe rather large; the one opposite at base of outer toe, small. Prominent tubercles beneath all the articulations. Vertebræ nine, in addition to the coccyx.

The entire body is strongly and coarsely granulated, conspicuously below, where it extends over the chin, between the arms, and on the arm nearly to the elbow joint; in fact, no part is free from the granulation, except perhaps the sides of the head. The upper and under faces of the thighs are also similarly granulated.

In the males the upper parts are purplish-brown (greenish-brown in life) with dark slate-brown markings; beneath cream color. There is a triangular patch between the eyes, the base extending directly across, the apex pointing down the back, the sides concave. In front of this, in the axis of the head and between the nostrils, is a small longitudinal streak. A dark patch commences on the side of the snout and extends backwards on the side of the head, including the tympanum, and, widening on the sides, fades out near the groin; the upper margin of this is most distinctly defined. The extreme margin of the upper jaw is dark mottled, but just above it and below the lateral vitta is a narrow line of yellowish-white, which widens after passing below the tympanum and, crossing above the shoulder, runs into the light color of the under parts, completely isolating the fore-leg. In the male the chin is mottled black; and in all there is a narrow, indistinct streak of brown extending from the lower jaw to the outer surface of the arm, continuous with the ground color there. On each side of the back extends a distinct stripe, from near the tympanum to about opposite the termination of the lateral stripes. An additional stripe is seen down the middle of the back, scarcely commencing so far forward; the three stripes nearly parallel, though with a tendency in the outer ones to diverge posteriorly. These stripes are sometimes irregular in outline, the central one sometimes broken up into blotches, the exterior ones less frequently. Sometimes scattered blotches are seen between the stripes. The upper surfaces of the limbs are indistinctly banded transversely, sometimes only blotched confusedly; the posterior faces of the buttocks are brown, with circular whitish spots on the apices of the granulation. The inner faces of the limbs are uncolored.

In some specimens, which appear to be principally females, the ground color above is fawn, sometimes light bluish-gray; and, as already remarked, the longitudinal stripes are occasionally broken up into coarse

or fine blotches. A general triserial arrangement is, however, almost always perceptible.

FIG. 86. *Chorophilus feriarum.* Mount Carmel, Ill.; 1-4, ½; 6-7, ¾.

Measurements, in inches.

Total length	1.06	1.00	Hind foot	.50	.47
Femur	.50	.47	Hind leg	1.77	1.67
Tibia	.54	.51	Width of head	.40	.37
Tarsus	.34	.32	Length from joint of jaw	.40	.37

A specimen taken by me in Trough Creek Valley, Huntingdon County, Pa., has broad uninterrupted bands, as in the *C. triseriatus* but has not its median muzzle band. The voice of this animal was similar to that of the latter species.

A specimen of nearly the size and form of *Hyla femoralis* was taken in west Pennsylvania, near the Kiskiminitas River. In proportions it does not differ from the Feriarum, but the toes are fringed, the dilatations larger, and the coloration different. Above blackish-ash, abruptly defined on the sides. Lateral band not extending beyond tympanum. No median dorsal band, but two black dorsolaterals of double ordinary width converge from each tympanum and extend to end of urostyle inclosing with the interorbital triangle a narrow, anteriorly bifurcate dorsal band of the ground color. The note of this species is quite different from that of the *C. triseriatus*, not being continuous, but in sets of crepitations repeated in time and at intervals.

This variety may not be more allied to the Feriarum than to the others, and may be called *C. feriarum brachyphonus.*

Chorophilus feriarum Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3592	.....	Carlisle, Pa	.....	S. F. Baird	
12077	.....	Mount Carmel, Ill	.....	L. W. Turner	
12708	.....	Lookout Mountain, Tenn	.....	.....	
13373	.....	Wheatland, Ind	.....	.....	
9667	3	Prince George's County, Md.	1878	Dr. T. H. Bean	

CHOROPHILUS TRISERIATUS, Wied.

Hyla triseriata Prince Maximilian Reise in das innere Nord-Amerika, I (1839), 249.
Helocœtes triseriatus Baird, Proceed. Ac. Phila., VII, 1854, p. 60.
——— *clarkii* Baird, *l. c.*, and U. S. Mex. Bound. Surv., Rept., p. 28, Pl. 37, fig. 4–9.
Chorophilus triseriatus Cope, Check-List N. Amer. Reptil., p. 30.
——— *septentrionalis* Boulenger, Cat. Batr. Sal. Brit. Mus., p. 335, 1882.
Hylodes maculatus Agassiz, Lake Superior, 1850, p. 378, VI, figs. 1, 2, 3.

In general shape this species is more elongated and less squat than *H. feriarum*, and the hind legs are materially shorter. The head is considerably more pointed. The nostrils, being a little more in advance than in Feriarum, are still over the end of the lower jaw, although the projection of the upper jaw is greater than in the latter. The distance between the anterior canthi of the orbits is more than half that between the rami, and this latter distance less than the chord of either ramus. The tympanum is small, less than half the diameter of the eye; its anterior border on a line with the angle of the mouth.

The granulation of this species is very distinct, extending over the whole body, except on the interior faces of the hind legs. It is most conspicuous and distinct beneath, and is seen on the under face of the arms, especially evident in the palms of the hands.

The tongue is rather thinner than usual in Feriarum and free for a greater distance behind, less emarginated posteriorly. The inner nares are circular and nearer the anterior canthus orbitalis than the external nostril. The vomerine teeth are considerably within and behind the centers of the posterior nares. The eyes about as in Feriarum.

The fore-arm is a little longer than the hand. The arm from the elbow is not so long as the hind foot. In general, while the thigh, leg, and tarsus are shorter in proportion, the foot is as long as or even longer than in Feriarum. The leg and thigh are nearly of the same length, and about two-fifths the length of the body. When the hind leg is flexed and applied along the sides, the tips of the toes reach only to the axillæ. The fingers and toes are much as in *H. feriarum*, though with all the limbs, more slender.

The ground color above and on the sides is of a light ash, in most specimens striped with brown; beneath yellowish-white, with a few scattered brownish dots on the sides and sometimes extending across the breast behind the arms. There is no transverse band between the eyes, but, instead, an oval spot above each orbit, and between these a distinct stripe starting between the nostrils and extending backwards to about the middle of the back, where it bifurcates at a very acute angle and continues, margining the urostyle, as it were, to near the anus. On each side of this dorsal mark is a stripe of similar width, starting in a line with the orbital blotches, but behind them and extending nearly to the groin, having a slight curve outwards to retain parallelism with the dorsal fork. A well-defined stripe starts at the snout and passes backwards through the eyes and tympanum over the shoulder

and down the sides to a point opposite the end of the stripe just described and parallel to it; in fact, we may distinguish anteriorly five distinct dark stripes, and posteriorly six, all about the same size, at the same distance apart, and parallel to each other. The extreme margin of the upper jaw is brown, but between it and the facial stripe is a narrow, well-defined line of white extending under the tympanum across the shoulder to be lost on the side. The marginal dark marking on the upper jaw is continued across the angle of the mouth (with a slight interruption over the canthus) up the arm, in a narrow line. The legs are all irregularly marked with rounded dark blotches, not fasciated; the buttocks brown, with whitish spots on the granulations.

Some specimens are much darker than the one just described, and occasionally there is a tendency to irregularity in the outlines of the stripes, almost breaking them up into spots, in which, however, the serial arrangement is always evident. Sometimes, too, the edges of the stripes are deeper colored than the middle.

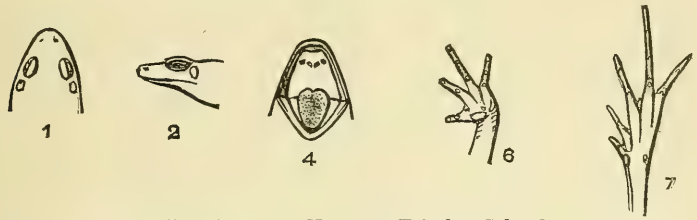


FIG. 87. *Chorophilus triseriatus.* No. 8553. Fairplay, Colorado; 1-4, ½; 6-7, ⅔.

	Inches.			Inches.	
Length of body	1.08	1.00	Hind foot	.50	.46
Arm	.55	.51	Hind leg	1.52	1.41
Femur	.40	.37	Chord of head	.32	.29
Tibia	.45	.42	Width	.30	.28
Tarsus	.28	.27			

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3859	7	Racine, Wis		Dr. P. R. Hoy	
3588	1	Cook County, Ill		R. W. Kennicott	
3308		Fort Union, Dak		Dr. J. Suckley	
5918	}	Fort Resolution		Dr. Kennerly	
5934	}				
3314		Laramie River		W. S. Wood	
3619		South Grand River, Missouri.		(?)	
3621		Saint Louis, Mo		Dr. G. Engelmann	
3307		Blue River, Kansas		(?)	
5382		Selkirk Settlement		R. Kennicott	
5146		Red River of the North		do	
3307		Salt Lake Valley		J. S. Bowman	
3316		Fort Union, Dak		Dr. F. V. Hayden	
3311		Upper Missouri		do	
3306		Fort Pierre		do	
3317		do		Gov. I. I. Stevens	

In some specimens from the Missouri River the head appears to be narrower and more elongate, the tongue more orbicular and less notched.

The granulation on the lower parts seems finer. The ground color is darker, though the pattern is much the same. The dorsal stripe does not bifurcate so soon, however; there is a tendency to spots between the stripes, and there are no spots on the breast.

Measurements, in inches.

Total length	.76	1.000	Hind leg	1.03	1.368
Tibia	.29	.381	Width of head	.20	.263
Femur	.26	.360	Length of chord	.26	.340
Hind leg from heel	.54	.710	Fore-arm from elbow	.30	.396
Hind foot	.36	.473			

The *Chorophilus triseriatus* abounds throughout the northwest, east of the Rocky Mountains.

I obtained it at Franklin, on the Utah-Idaho boundary, and subsequently found it very common in the ruts of the wagon trails on the plains east of Fort Benton, Mont. In the latter locality it was generally of a bright green color.

Specimens from Gloucester County, New Jersey, present the following characters:

Body longer; head contained three and two-thirds times in total length, the width three to three and one-half in same; tibia measuring half the distance from vent to middle and anterior border of orbit; smaller tympanum; teeth nearer each other than to nares; five longitudinal bands.

In this form the limbs are rather stout, with their upper surfaces granulated or rugulose. Toes fringed or margined. The heel extends to the orbit; tympanum one-third of latter. One, an inner tarsal tubercle. The median dorsal band is broad, unites with the interocular triangle, and is continued part way to the end of the muzzle, giving a cruciform figure. Dorsolateral bands nearly straight, commencing some distance above and within the tympanum. Lateral stripe complete from end of muzzle nearly to groin. Ground color fawn; below pale, immaculate. Posterior limbs with half cross-bands.

Measurements.

	Lines.		Lines.
Total length	12.66	Tibia	5.66
Fore limb	7	Foot	9.5
Femur from vent	5		

This species I have found abundant on the sides of pools and ponds in the neighborhood of Gloucester, N. J. in the spring and early part of summer. It delights in those small and often temporary pieces of water which are inclosed in the densest thickets of spiny Smilax and Rubus, with scrub oaks, and surrounded by the water loving Cephalanthus, where no shade interrupts the full glow of sunlight. Here they may be heard in the hottest part of the day, accompanied with a few scattering Acres, or rarely a *Hyla pickeringii*. Their retreats are not sought by

Ranæ. As they scarcely swim, when surprised they seek refuge in the edge of the water, with so little movement as to render their capture no easy matter.

This species commences its season early. I have heard the swamps of the barrens and thickets of southwestern New Jersey resound with them as early as the twentieth of March, when a skim of ice covered part of the water. I have also heard it in other level paris of the same State later in the season, and in the lower part of Chester County, Pa. Its note resembles that of the Acris in being crepitant, and differs from the toned cry or whistle of the Hylæ. It is not so loud as the former and is deeper pitched; it may be imitated by drawing a point strongly across a coarse comb, commencing at the bottom of a jar and bringing it rapidly to the mouth; or, better, by restraining the voice to the separate vibrations of the vocal cords, and uttering a bar of a dozen or twenty vibrations, beginning with the mouth closed and ending with it well opened.

The spotted form, called by Professor Agassiz *Hylodes maculatus*, presents the following characters. The description is made from Professor Agassiz's typical specimen.

This variety is of much the same delicate form as Triseriatus. The head is small and narrow. The limbs are short; the tibia two-fifths the length of the body.

The tongue is oval, nearly as wide as long; rather thicker than usual; free behind, and scarcely, if at all, emarginated. The teeth are in two very small circular patches, each situated within and but little behind the internal nares: separated by a wider interval than usual. The tympanum is small and inconspicuous, not half the diameter of the orbit; the distance between the anterior canthi of the orbits is barely more than half that between the rami of the lower jaw, which is a little less than the chord of the ramus.

The fingers and toes are cylindrical, truncate, and rounded at the tips; not dilated, but somewhat knobbed. The outer finger is longer than the third; the first is directed nearly at right-angles with the third, and considerably removed from the others. The outer toe is longer than the third; the web is confined to the intervals between the metatarsals, except a slight development between the bases of the fourth and fifth. A rounded tubercle at the base of foot on each side. Body everywhere granulated except on the interior surfaces.

The ground color is of a brownish-ash above, with crowded and elongated blotches of darker arranged irregularly, or not serially, as in most other varieties; a dark stripe on the side of the head through the tympanum and extending to the shoulder, and in one specimen an elongated blotch on the side of the body may almost be considered a prolongation of the same. There is the usual light line along the edge of the jaw, extending to the arm. The limbs are blotched above, but

not fasciated. Beneath yellowish-white, with scattered brownish spots across the breast.

Measurements, in inches.

Total length	1.02	1.00	Tarsus	.29	.28
Fore-arm from elbow	.42	.41	Foot	.50	.49
Hand	.26	.25	Total of hind leg	1.56	1.53
Femur	.39	.38	Width of head	.32	.31
Tibia	.43	.42			

No. 3594; three specimens; Lake Superior, north shore; Prof. L. Agassiz.

The Texan form described by Baird and Girard as *Helœcetes clarkii* has the following characters. It forms the transition between those with longitudinal stripes as Triseriatus and the irregular spotted Maculatus from Lake Superior. It presents the usual features in the acute head, entirely granulated body, except on the concealed surfaces (the granulation is quite coarse), nearly free toes, etc. The head is acute and elongated; the snout projecting more than in Maculatus.

The tympanum is large, about two-thirds the diameter of the orbit. The external nares are very near the tip of the snout, or at about one-third of the distance from snout to orbit; they are separated by less than one-third the width of the rami. The internal nares are decidedly more separated than the external, and distant about one-third the interval of the rami. The vomerine teeth are in two very small rounded, depressed patches, having a considerable interval, and in a line with the posterior edge of the inner nares. The tongue is broad, ovate, slightly emarginate behind; thin on the edges.

The fingers and toes are cylindrical, slender, and dilated or thickened at the tips into rounded, depressed knobs. In the hand the outer finger is longer than the second; the cleft between the second and third is deeper than that of third and fourth, and there is the appearance of a very slight basal membrane between them, entirely wanting between first and second. The outer toe is rather larger than the third; all the toes are connected by a slight basal web, which, however, scarcely extends beyond the metatarus; two tubercles at base of foot. The tibia is less than half the length of the body; about half the distance from anus to the eyes.

Color above brownish-ash, with the back covered by ten to twenty large circular dark blotches, arranged in some specimens in two longitudinal series, with a few smaller intermediate ones; in another distributed uniformly over the back, separated by considerable intervals; a narrow dark line from snout through nostril to the eyes, thence through the tympanum, fading out on the sides of the body posteriorly. A narrow light line along the edge of the jaw to the arm. A few large subquadrate blotches on the upper surface of the limbs. Beneath, yellowish-white, with the gular sac tinged with brown.

Differs from Maculatus in smaller number of spots, which are less confluent and more clustered, more slender form and longer tibia, with shorter feet; from the other varieties in being without dorsal stripes.

Measurements, in inches.

Total length	.78″	1.00	Foot	.34	.45
Arm from elbow	.34	.45	Total hind leg	1.18	1.51
Femur	.30	.39	Maximum width of head	.27	.35
Tibia	.38	.49	Chord of rami	.28	.36
Tarsus	.23	.30			

No. 3317; one specimen; Indianola; J. H. Clark, United States and Mexican Boundary Survey.

In one specimen the colors are much brighter. There is a distinct dark broad band from the snout through the eye, fading out about halfway down the side. A narrow white line along the edge of upper jaw to posterior insertion of arm. The blotches above are much darker; there is a triangular one between the eyes, extending backward, and those on one side are confluent into a longitudinal band with irregular outline. The blotches on the opposite side to this are elongated and rather oblique. The dark stripe from the jaw along the arm is here wanting. Other characters similar.

No. 3315; one specimen; between Indianola and San Antonio, Tex.; J. H. Clark. I have also this form from Helotes, Fort Concho, and Dallas, Texas, so that it is generally distributed throughout the State, to the exclusion of the ordinary form.

Chorophilus triseriatus Wied.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8553	5	Fairplay, Colo	July 11, 1873	Dr. J. T. Rothrock	Alcoholic.
3588	3	West Northfield, Ill		R. Kennicott	Do.
5934	3	Fort Resolution		do	Do.
3309	2	Fort Union, N. Mex		Lieutenant Gross, U.S.A	Do.
3306	4	Fort Pierre, Nebr		Governor Stevens	Do.
4573	1	Blue River, Kansas		Dr. J. G. Cooper	Do.
5146	2	Red River of the North		R. Kennicott	Do.
8552	1	Pagosa, Colo		Dr. H. C. Yarrow	Do.
8551	1	do	Sept. —, 1874	do	Do.
3619	2	South Grand River, Western Missouri.		Dr. P. R. Hoy	Do.
5382	6	Selkirk Settlement		R. Kennicott	Do.
9633	1	Fort Garland, Cal	June —, 1872	H. W. Henshaw	Do.
3313	1	Galveston, Tex		M. Dean	Do.
	9	Fort Pierre, Dak		T. Culbertson	Do.
	2	Between Fort Union and Pike Lake, Dak.		Lieutenant Grover	Do.
	1	Between Fort Union and Fort Benton, Dak.		Dr. G. Suckley	Do.

CHOROPHILUS OCULARIS Holbrook.

Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 333.

Hylodes ocularis Holbrook, N. Amer. Herp. 1st ed., II, 79, Pl. XIV, 1838; and 2d ed., IV, 1842.
Hyla ocularis Le Conte, Proceed. Ac. Phila., 1854, p. 429.
Chorophilus angulatus Cope, Check-List Batr., Reptil., N. Amer., 1875, p. 30.

Eyes large; head acute; lower jaw narrow; tibia rather more than half length of body, decidedly longer than hind foot; terminal knobs well developed. Above chestnut, with an obscure darker dorsal band from snout to eye, bifurcating behind, and another on each side. These usually more or less obsolete; a much deeper dark chestnut vitta from snout through eye and tympanum, along the sides; below this is a distinct white line; a light line along the outer edge of the tibia.

This species, which appears to be the smallest of the genus, and indeed the smallest of all the North American ecaudate Batrachia, has a close generic relationship to the other species. Its most striking features will be found in the large size of the eyes, the acuteness of the head, the small tongue, etc. The tibia is longer than in any of the genus.

The head is more pointed than usual, a character best seen in the lower jaw; which, instead of being regularly rounded, has the rami nearly straight for two-thirds, then acutely rounded, almost V-shaped. The tongue is small, ovate, entire behind, and free for half its length. The vomerine teeth are not distinguishable. The tympanum is very small, scarcely perceptible, and less than half the diameter of the eye.

The limbs are well developed, compared to the other species. The tibia is rather more than half the length of the body.

General color above dark chestnut, with an obscure dorsal stripe of darker from the snout to the posterior portion of the back, bifurcating behind. On each side of this is a similarly obscure stripe, while a much deeper and more distinct stripe extends along the side of the head, through the eyes, and along the flanks. Below this, on the edge of the upper jaw, is a white line, extending beyond the shoulder. Beneath yellowish-white, with obscure dark spots across the breast and chin. Faint indications of transverse bands across the thighs and legs, more decided than in the other species. The outer edge of the tibia is occupied by a distinct light line, on the inside of which is a darker mottling.

In general it is distinguishable from all the allied species by its acute lower jaw, chestnut color, and light line down the outer edge of tibia.

Measurements, in inches.

Total length	.64	1.00	Hind foot	.26	.40
Tibia	.33	.51	Hind leg	1.09	1.70
Femur	.30	.47	Width of lower jaw	.18	.28
Hind leg from heel	.46	.72	Chord	.21	.33

No. 3585; 3 specimens; Charleston, S. C.; C. Girard.

The specimens of this species are for the present inaccessible to me. I therefore have given above a MS. description of Professor Baird's.

HYLA—Laurenti.

Specimen Synopsis Reptilium, 1768, p. 32; Dum. & Bibr., p. 542; Günth., Cat., p. 98; Cope, Nat. Hist. Rev., 1865, p. 110, and Journ. Ac. Phila. (2), VI, 1866, p. 86, and 1867, p. 200; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, 2d ed., p. 337.

Calamites Fitzing., N. Class. Reptil., p. 38; Wagl., Syst. Amph. p. 200; Tschudi, Class. Batr., p. 72; Cope, Journ. Ac. Phila. (2), VI, 1867, p. 200.
Auletris Wagl., *l. c.*, p. 201.
Hyas Wagl., *l. c.*, p. 201.
Scynax Wagl., *l. c.*, p. 201.
Sphœnorhynchus Tschudi, *l. c.*, p. 71.
Lophopus Tschudi, *l. c.*, p. 73.
Dendrohyas Tschudi, *l. c.*, p. 74.
Ranoidea Tschudi, *l. c.*, p. 76; Cope, Journ. Ac. Phila. (2), VI, 1866, p. 85.
Litoria Tschudi, *l. c.*, p. 77; Dum. & Bibr., p. 503; Günth, Cat., p. 96.
Hylomedusa Burmeister, Erläuter. Faun. Bras., p. 102.
Chirodryas Keferst., Götting. Nachr., 1867, p. 358.
Cophomantis Peters, Mon. Berl. Ac., 1870, p. 651.

Frontoparietal bones not developed, consisting of two narrow, separated supraorbital plates. Ethmoid largely developed anteriorly, dilated over the anterior part of the orbits, widely separating the oblique prefrontals. Urostyle attached to two condyles. Belly areolated. No parotoid gland. Pupil round or transverse. Vomerine teeth present. Tongue attached to one-third free, posteriorly. Digital dilatations large or small; a more or less extensive web between the posterior toes. Corium not involved in hyperostosis of the cranial bones.

This genus, embracing more than half the family of Hylidæ, furnishesa type of structure intermediate between the extremes offered by other genera, of which that represented by Hypsiboas may be said to be the most typical. This genus is in some degree an epitome of the family in its distribution. The Hylidæ have been created to inhabit the vast world of foliage that shades the tropics of the New World, and restrict the insect life that peoples it, and in proportion to this profusion of vegetable life is the abundance of species. The arboreal Anura assigned to the same department of the Old World is of a widely different type, and, as has been shown, a branch of the higher stock of aquatic frogs that abound in the Northern Hemisphere.

Of the one hundred and eight species of Hyla, forty-three occur in regions other than the Neotropical, viz, twenty-nine Australian, nine Nearctic, three Palæarctic, and two Palæotropical, as follows:

Australian.

H. nasuta.	H. dentata.
H. freycineti.	H. citropus.
H. dimolops.	H. ewingii.
H. latopalmata.	H. phyllochroa.
H. affinis.	H. gracilenta.
H. nigrofrenata.	H. rubella.
H. leseuerii.	H. kreftii.
H. obtusirostris.	H. adelaidensis.
H. arfakiana.	H. jervisiensis.
H. vagabunda.	H. peronii.
H. impura.	H. montana.
H. thesauriensis.	H. infrafrenata.
H. parvidens.	H. cærulea.
H. verreauxii.	H. dolichopsis.
H. congenita.	H. lutea.

Nearctic.

H. andersonii.	H. femoralis.
H. carolinensis.	H. arenicolor.
H. squirella.	H. versicolor.
H. regilla.	H. gratiosa.
H. pickeringii.	

Palæarctic.

H. arborea.	H. stephani.
H. chinensis.	

Palæotropical.

H. annectens.

Between species of Australia and South and North America there exist close relations. Those of smallest size occur in North America, where several spend but little of their time in trees, but like the African Hyperolii prefer low lands and swamps. Larger species of similar habit occur in Australia.

The distribution of the North American species is as follows:

Austroriparian District.	*Eastern District.*	*Sonoran District.*	*Pacific District.*
H. versicolor.	H. versicolor.	H. arenicolor.	
H. gratiosa.			
H. femoralis.	H. pickeringii.		
H. squirella.		H. regilla.	H. regilla.
H. carolinensis.	H. andersonii.		

Of the eastern species, *H. versicolor*, *H. pickeringii*, and *H. andersonii*, are the only ones which extend their range north of southern North Carolina. *H. andersonii* has been found so far, east of the Appalachian range, from New Jersey to Georgia. *H. versicolor* and *H. pickeringii*

are characteristic of the whole region, occurring east of the Central Plains to the Atlantic, and from British America to Florida and Texas.

H. regilla of the Pacific district extends its range from British Columbia to Cape San Lucas and into New Mexico and Northern Mexico, presenting considerable variation in characters.

With regard to the distribution of this genus in the Regio Neotropica, a synopsis had already been given under the head of the family. But two species occur in the West Indian district, and these are both in Santo Domingo only. The species of the outlying districts are:

Mexican.

H. uranochroa.	H. puma.
H. ebraccata.	H. quinquevittata.
H. bistincta.	H. microcephala.
H. nigropunctata.	H. punctariola.
H. elæochroa.	H. gracilipes.
H. salvini.	H. miotympanum.
H. gabbii.	H. spilomma.
H. nigripes.	H. curta.
H. staufferi.	H. pulverata.
H. eximia.	

Colombian.

H. sordida.	H. labialis.
H. phæota.	H. punctariola.
H. molitrix.	H. rhodopepla.
H. splendens.	H. lichenosa.

West Indian.

H. vasta.	H. pulchrilineata.

Chilian.

H. zebra.

In all but two of the species which I have examined the vocal sacs are present; they communicate with each other posteriorly in *H. fusca* and *Smilisca baudinii*. The adhesion of the integument is opposite the middle of the tongue in these species; in *H. carolinensis*, opposite the posterior end. In *H. leseureii* and *H. curta* the vesicles are wanting in the males.

I. Fingers entirely free; fascicles of vomerine situated posterior to a line connecting the interior nares.

Three phalanges of fourth toe free; upper lip not spotted; thigh with a few brown specks behind; no distinct lateral stripe ..... *H. pickeringii*.

II. Fingers entirely free; vomerine fascicles between the internal nares.*

α. Three phalanges of fourth toe free from web.

Upper lip with a dark border; a dark lateral band on body; thigh unicolor behind; a vocal vesicle ..... *H. regilla*.

* In *H. squirella* the vomerine patches sometimes project posterior to the line connecting the nares.

Upper lip and side with a narrow, poorly defined yellow line; thigh unicolor behind; small; head rounded ..... *H. squirella.*

Larger; head short, rounded; upper lip unicolor; a plum-colored lateral band not defined below; sides and thigh behind spotted with yellow ..... *H. andersonii.*

αα. Two phalanges of fourth toe free.

Slender; head acuminate; a yellow band on upper lip and on side well defined above and below; thigh unspotted behind ..... *H. carolinensis.*

Robust; head rounded; no band on upper lips, nor spots on thigh behind ..... *H. arenicolor.*

III. External fingers shortly palmate; vomerine fascicles between nares.

α. Dorsal integument not closely areolate.

Three phalanges of fourth toe free; skin above smooth; upper lip unicolor; thigh behind dark brown with yellow spots ..... *H. femoralis.*

Two phalanges of fourth toe free; dorsal integument with small tubercles; upper lip spotted; thigh yellow, with coarse netting of darker color posteriorly ..... *H. versicolor.*

αα. Dorsal integument with a close areolation like that of the belly.

Two phalanges of fourth toe free; dorsal areolæ more minute than those of belly; upper lip with yellow edge; thigh behind unspotted. *H. gratiosa.*

The North American species of this genus are easy to distinguish, since they are well defined. The only one which presents much variation in characters is the *H. regilla.* A species was named and figured by Professor Holbrook as the *H. delitescens.* Other authors have not recognized this tree frog, and it remains uncertain whether it was not founded on immature specimens of the *H. versicolor.*

The damp southeastern part of the continent naturally possesses the greater number of species of this genus.

HYLA PICKERINGII Storer.

(Plate 78.)

Hylodes pickeringii Storer, Mass. Rept. (1839), 240; Holbrook, N. Amer. Herp., 2d ed., IV (1842), 135, XXXIV; De Kay, N. Y. Zool., III, Reptil. (1842), 69 XX, 51; Thompson, Nat. Hist. Vt. (1842), 121.

Hyla femoralis Nichols, Journ. Essex Co. Nat. Hist. Soc., I (June, 1839), 96 (Danvers, Mass.).

Hyla crucifer Max. Von Wied., Reise in das inn. Nord-Amerika, I (1839), 249.

Acris de pickering Aug. Duméril, Ann. des Sc. Nat., 3me série, XIX (1853), 153.

Acris pickeringii Günther, Cat. Batr. Sal. Brit. Mus., 1868, p. 71.

Hyla pickeringii Le Conte, Proceed. Ac. Phila, 1854, p. VII, p. 429; Cope, Check-List Batr., Reptil., N. Amer., p. 31, 1875; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 399.

Body sparsely pustular above; closely granulated on whole lower parts. Tibia not half the length of body, longer than hind foot, longer than arm from elbow. Above, ash-gray to wood-brown, with a well-defined narrow-lined X or Saint Andrew's cross on the back; a Λ-shaped mark behind the cross and a short line on each side, with their direction parallel to the posterior of the X angle; another similar mark between

the eyes nearly parallel to the anterior branches of the dorsal X. A dark vitta from the snout through the eye down the sides, and a narrow mottled light line along the jaw.

Feet not webbed beyond penultimate articulation of third and fifth toes and antepenultimate of the fourth toe.

In its general features this species agrees with the other American Hylæ, except that the membrane between the toes is somewhat less developed, and the transverse apophyses of the sacral vertebræ are not quite so much enlarged towards the tip. It forms an approach to Chorophilus, but has, however, large pallets to the extremities. It is still more removed from Acris.

The head is acuminate-ovate anteriorly, with the muzzle projecting well beyond the upper lip, and is contained a little over three times in the total length. The tympanum is about half the diameter of the eye and distinct. The tongue is very thin, subcordiform, rounded and emarginate behind, where also it is free. It varies in size in different individuals. The posterior nares are large, with the two groups of vomerine teeth approximated and arranged with their longer axis oblique, anteriorly behind the center of the nares, and posteriorly entirely behind their posterior borders.

The fingers and toes are well developed. The hand is longer than the fore-arm, and the two about equal or little longer than the hind foot, but not quite as long as the tibia, which is contained about two and a half times, or less, in the length of the body.

The disks are large and conspicuous. There is no membrane at the bases of the fingers, of which the third is longest, the fourth or outer longer than the second. The heel of the extended hind leg reaches to the middle of the eye. There are distinct tubercles beneath all the joints of the hind feet, and the two at the base of the foot are well developed.

The last three phalanges of the longest toe and the two last of the rest are free from membrane, which is also nearly absent along the inner edge of the antepenultimate phalange of the third toe.

The skin above is smooth, with occasional low pustules. The abdomen and lower part of the thigh are very distinctly granulated, as is the pectoral region and the chin to a less degree. Pectoral fold not prominent.

General color above, a pale grayish yellow with a dorsal X-shaped cross of narrow lines; beneath yellowish-white. The dorsal cross consists of a short longitudinal median dark line, whose middle is a little anterior to the middle of the back. Anteriorly this bifurcates acutely, sending off branches which reach nearly to the eyes; posteriorly, similar bifurcations, parallel in direction (sometimes nearly continuous) with the first, extend on to the sides of the body. Half-way between the posterior fork and the anus there are two other lines meeting at an acute angle and parallel to the branches of the posterior fork just mentioned.

On each side of the back, and in the center of the space between the anterior and posterior bifurcations, is a very short line, generally parallel in direction with the branches of the posterior fork. There is also a V-shaped line connecting the eyes (the apex behind), and a short longitudinal one above the snout. There is a narrow dark line from the snout to the eye, and another dusky tympanal vitta from the eye over the arm along the sides; this line is deepest on its upper edge, and more or less obsolete on its lower; sometimes it is not distinct beyond the arm. The edge of the jaws is mottled, leaving the ridge lighter above; scarcely distinct as a line. Sometimes a broad vitta may be said to pass from the snout through eye and tympanum; indistinct below. The legs above are barred transversely in narrow lines, and the whole upper parts finely sprinkled with dark points. The posterior faces of the thighs are marmorated or blotched with yellowish, on a brown ground; the anterior faces are plain. The outer edge of the soles and heel is mottled brown. The gular sac of the male is purplish-brown in the spring.

The species varies considerably at times in the tint of the body, being of all shades to reddish-brown. The marks on the back are sometimes quite broad and coarse, instead of being narrow and more linear than in other specimens. The gular sac is quite extensible and in spring is brown. Sometimes the throat and breast are spotted with brown.

H. pickeringii has more resemblance to *H. femoralis* than to any other species. This has the dorsal blotches, however, much coarser and never arranged as above described; nor are the peculiar circular light spots on a brown ground on the posterior face of the thighs ever seen in *H. pickeringii*. From young specimens of *H. versicolor* it may be distinguished by the narrow lines of the distinct dorsal cross and the slighter web of the hind feet, with the absence of the light spot on the jaw, as well as by the position of the vomerine teeth and the form of the muzzle.

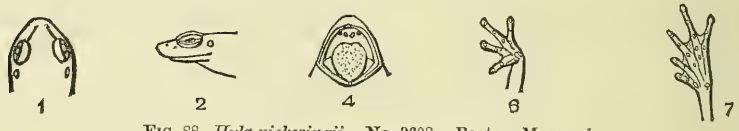


FIG. 88. *Hyla pickeringii*. No. 3608. Boston, Mass.; ½.

Measurements of No. 3609.

	M.
Length of head and body	.028
Length of head to posterior edge of tympana	.009
Width of head at posterior edge of tympana	.010
Length of anterior limb from axilla	.016
Length of posterior limb from groin	.045
Length of tibia	.015
Length of tarsus	.0085
Length of rest of foot	.013

Habits.—This, our most abundant eastern species, is much more generally known by its voice than appearance. After the rattling of the *Acris gryllus* in the marshes and river banks in the lowlands is fairly

under way, during the first bright days of spring, the shrill cry or whistle of this little creature begins to enliven the colder swamps and meadows of the hill country. Different individuals answer each other with differently toned voices of a single note. This is exceedingly shrill and loud; the muscular force employed in expelling the air from the lungs seems to collapse the animal's sides till they nearly meet, while the gular sac is distended with each expulsion to half the size of the head and body together. They are chiefly noisy in the end of the afternoon, but in shady situations or on dark days may be heard through the morning and noon. When the breeding season is over they may be still found, but with difficulty, among fallen leaves in low places, where their color admirably adapts them for concealment, or in cellars, or on the ground in the woods. Not till the near approach of autumn do we have evidence of their ascent into the trees. Then, when the wind is casting the first frosted leaves to the ground, a whistle, weaker than the spring cry, is heard, repeated at intervals during the day, from one part of the forest to another, bearing considerable resemblance to the note of the purple finch (*Carpodacus purpureus*), uttered as it is while flying. These voices are heard during the same season, that of the Hyla being distinguishable as slightly coarser, or more like a squeak. Both are associated with the weak chirp of the late *Dendræca coronata* as it gleans its insect food on its southern flight. These are the latest sounds of autumn, and soon disappear before the steady advance of the ice king.

Hyla pickeringii Holbrook.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3604	1	Aux Plaines River, Ill..	.....	R. Kennicott	Alcoholic.
3609	1	Marietta, Ohio.....	.....	Prof. E. B. Andrews	Do.
3602	1	Carlisle, Pa.....	.....	Prof. S. F. Baird.....	Do.
3603	1	Abbeville, S. C.....	.....	Dr. J. B. Barratt	Do.
3608	2	Boston, Mass	.....	Prof. L. Agassiz	Do.
3505	1	Elizabethtown, N. Y	.....	Prof. S. F. Baird	Do.
3610	1	Carlisle, Pa.....	.....	.....do	Do.
9669	1	Prince George's County, Md.	.....	Dr. T. H. Bean	Do.
5380	2	Selkirk Settlement.....	.....	R. Kennicott.....	Do.
	2	Cambridge, Mass	.....	Prof. L. Agassiz	Do.
	1	.....do	.....	C. Girard	Do.
	1	Grosse Island, Mich	.....	Rev. Charles Fox	Do.
	.....	Ann Arbor, Mich.....	.....	Dr. A. Sager.....	Do.
	7	Cook County, Ill.....	.....	R. Kennicott.....	Do.
13325	10	Washington, D. C.....	.....	George Shoemaker	Do.

HYLA REGILLA Baird and Girard.

Proceedings Academy Philada., VI, 1852, p. 174; Girard U. S. Expl. Exped., Wilkes, 1858–1860, III, figs. 13–18.

Proportions somewhat as in *H. versicolor*. Canthus rostralis distinct, rather elevated; muzzle obtuse. Digital dilatations rather small; fingers free; toes half webbed or less. Nares and choanæ small; vomerine teeth in fascicles between former. Tongue large, nearly half free, emarginate. Tympanum less than half eye. Skin above usually

sparsely pustulated. Form of cranium variable; width at jaws from three and one-fourth to two and two-thirds times in length of head and body; from posterior margin of orbit to muzzle three and one-half to nearly four times in same. Olive or ash green above, plain or marked on each side, with blotches in two longitudinal series or stripes of darker and scattered smaller ones on each side of these. Frequently a triangular blotch between the eyes. A narrow dark line from snout to eye; a broad postocular vitta to the arm, beneath which is a bar of grayish-white about half the width. Tibia half to two-fifths the length of the body; hind foot and arm from elbow scarcely shorter.

This species, like the *H. pickeringii* and *H. curta*, is annectant to Chorophilus, whose species it represents, as well as its own genus, on the Pacific slope of North America. The diminished web and digital palettes constitute the resemblance; but they fall, nevertheless, within the range of the Hyla type. The *H. regilla* is distributed throughout its subregion and into the adjoining one of Arizona and Lower California under a slightly different form. Southern California possesses another variety along with the typical one. These varieties differ, as do those of the *Chorophilus triseriatus* in the proportions of the head and body; the first a long-headed and longer-bodied type; the most common, a shorter headed and longer bodied; and the most southern form, a still shorter headed and short bodied, with more varied coloration.

Head elongate; width enters length of head and body considerably over three times; canthus rostralis straight; a triangular patch between eyes ..... *scapularis.*
Head short; width one-third of length ..... *regilla.*
Head short, broad; breadth contained in total length two and two-thirds times; form squat ..... *laticeps.*

I can not regard these forms as subspecies.

Var. *scapularis.*

Hyla scapularis Hallow, sp. from South California, U. S. Pac. R. R., Rept., X, 350, p. 21.

Three specimens, said to be from San Francisco, are all that the Museum Smithsonian possesses of this variety, which is proportioned somewhat as the true var. Triseriatus in the Chorophilus of that name. The metatarsal bones are more closely bound and the web is less than in other forms. The skin is nearly smooth. Besides the interocular triangle there is a dark dorsolateral band and in one a median dorsal. In one specimen the tibia measures half the distance from the vent to the anterior angle of orbit, another half-way to end of muzzle.

This variety has every appearance of a terrestrial animal. It will no doubt be found to be connected with the ordinary type by annectant forms.

VAR. *regilla.*

Hyla regilla B. & G., Proceed. Ac. Nat. Sci., Phila., VI, 1852, 174, 1853, 301; Girard, Herp., U. S. Expl. Exped., 1858, 60, Vol. III, Figs. 13–18; U. S. Pac. R. R. Surv. Rept., Williamson Abbot, 12, Pl. XXVIII, Fig. 3 (bad).

Hyla scapularis Hallowell partim, Proceed. Ac. Nat. Sci. Phila., VI, 1852, 183, and var. *hypochondrialis*, U. S. Pac. R. R. Surv., X., 35 lat., p. 21.

There are three styles of coloration prevalent among individuals of this variety, viz: That which prevails among more northern specimens, but which occur as far south as San Diego, where longitudinal bands are wanting or broken into irregular small spots, and where the interocular triangle is often wanting. Second, where the general color is darker, with three broad dorsal bands or the spots into which they are resolved. The largest specimens are of this type; numbers having been brought from Fort Tejon and a few from northward. Third, represented by a large female specimen from Monterey, Cal., is without markings above, but the borders of the exterior color of tibiæ, the sides, and the pectoral region are closely brown spotted; in all the others the under surface are immaculate. The tints of this style seem to be more delicate, and it has a more hyline aspect than some of the others.

Head small, rather pointed, but broader than long. Tympanum small, nearly half the diameter of the eye. Eyes not very prominent; a slight fold of skin above the tympanum. A very prominent one across the breast. Skin above finely pustulated with larger scattered tubercles, not so close as in *H. versicolor*. Tibia about half the length of the body. The gular sac is largely developed.

Disks on extremities large; the largest equaling the tympanum. The hand considerably longer than the fore-arm; outer finger longer than the second; a slight web at base. Tibia half the length of body. Outer toe a little longer than the third. Membrane extending from disk of outer toe to middle of the third joint (from the tip) of the fourth or longest; from the third articulation (from tip) of the fourth toe obliquely to the disk of the third toe; from the third articulation of the third toe to the disk of the second; from the second articulation of the second toe to penultimate articulation of the first. Thus the membrane is nearly wanting along the inner side of three terminal joints of the third and fourth toes and the two terminals of the second, while on the outside it extends nearly or quite to the disks of the second and third and to the penultimate articulation of the first and fourth. A prominent tubercle at base of inner toe and a smaller one opposite on the sole. Expansion of sacral apophyses not very great. The heel of the hind leg extended reaches to the anterior border of the orbit.

In a very large specimen the general color above is a greenish-ash (in some a dark olive) and blotched with darker. There is a conspicuous subequilaterally triangular patch between the eyes, extended acutely backwards for a short distance. The back is variously blotched; the most conspicuous of the blotches are considerably elongated, and arranged one or two in a line on each side of the back in a line with the eyes and parallel; the middle of the back and the extreme sides of the body are sparsely provided with smaller, usually subcircular, sometimes elongated blotches. There is a distinct and rather broad dark line from the snout through the nostrils to the eye and a wider vitta from the eye, involving the whole tympanum, to a little past the

insertion of the fore-arm. The extreme edge of the upper jaw is dark, and the space between this and the preocular line rather lighter than the ground color. In the extension of this light space backwards it becomes lighter, until from beneath the eye it passes below the postocular band to the base of the fore-arm as a grayish-white vitta, usually about half as broad as the one above it. Sometimes a series of scattered rounded spots may be traced along the side in continuance of the dark postocular vitta. The extremities above are transversely and narrowly but indistinctly barred with darker. The rest of the legs is uniformly flesh color (thighs posteriorly dusky) except a few aggregated pustules below and about the anus, which are white (no marking on the inner faces of limbs); this is seen in other species, but is very distinct here. The immediate border of the anus is brown; beneath, white; edge of gular sac, black.

In some specimens, especially those from Fort Tejon, the prevalent color above is ash-gray, with an elongated blotch along each side of the back for its whole length, and one or two others on each side of those dorsal blotches are nearly wanting. Sometimes the exterior edges of the tibia and feet (when flexed), are blotched with brown.

This variety resembles *H. squirella*, but the head is less depressed; the colors are darker; the dorsal blotches are larger, and elongated longitudinally in two or three series; the white margin to the much darker postocular vitta is broader; the body is stouter, and usually more or less granulated. The toes are less deeply webbed.

The figure of this species in volume ten of the Pacific Railroad Surveys represents an interdigital membrane anteriorly, which does not exist, and that of the posterior limb is too extensive.

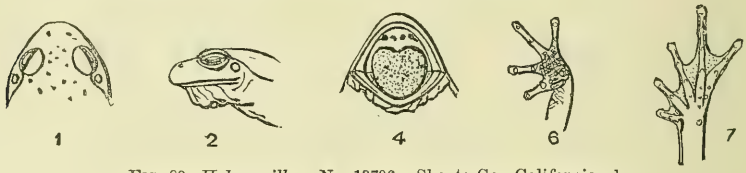


FIG. 89. *Hyla regilla*. No. 13796. Shasta Co., California; ½.

Measurements of No. 8688.

	M.
Length of head and body	.039
Length of head to posterior line of tympana	.011
Width of head at posterior line of tympana	.014
Length of fore limb	.022
Length of hind limb	.053
Length of tibia	.017
Length of tarsus	.010
Length of rest of foot	.015

The specimen measured is of medium size; another from the same locality has the length of the head and body equal to 45mm.

This, the only species of the Pacific region, is quite abundant there. I have caught them along the western edge of the Great Basin in Nevada and Oregon, where they inhabit the marshes which surround the

lakes of that region. In such localities they can not have arboreal habits, owing to the absence of trees; and it is probable that their habits are like those of the *Hyla pickeringii* of the east.

I append a description of the type specimen of the *Hyla nebulosa* Hallowell (U. S. Pac. R. R. Survey Rept., 35th parallel, Reptiles p. 21), which I afterwards called *H. cadaverina*, owing to the pre-occupation of Hallowell's name. The single specimen known is now in bad condition, and I am not sure that it should not be referred to the *H. regilla*. The description now given was taken from the specimen when nearly fresh.

Size medium; form stout; legs elongate; head short, broad, breadth less than three times in the total length; muzzle rounded, little prominent; canthus rostralis straight, elevated; fingers free; toes two-thirds webbed; the digits short, stout; the pallettes large; a strong tarsal wing or fold; eyes small; skin smooth.

Femora unicolor behind; no dark labial border or dark or light lateral stripes; color pale, with indistinct blackish dorsal spots.

The heel of the extended hind limb extends to between the orbit and the end of the muzzle; the largest digital dilatations equal the tympanum, which is indistinct and one-fourth the size of the eye. The eye is smaller and less prominent than usual, its long diameter measuring the width between canthus rostralis at orbits, one and one-third times, and two-thirds length of the brachium. Foot one and three-fourths and one and five-sixths breadth of head at canthus oris; vomerine teeth entirely between the nares, which appear larger than the ostia of the Eustachian tubes.

Sacral diapophyses elongate; triangles very narrow proximally; upper surface slightly convex, thus differing from the eximia, where they are broader, flatter, and not so produced. Skin nearly smooth above; abdominal areolations not extending on the sides; a pectoral fold. Toes stout, margined; the dilatations large (not proportionally to the digits), except on the thumb.

Above gray, with an interocular and numerous dorsal irregular blackish spots. Canthus rostralis and band behind eye dark shaded; lip and prebrachial region light, dark punctulate. Limbs indistinctly cross-barred; below yellowish, immaculate.

	Lines.
From end of muzzle to canthus oris	5.9
From end of muzzle to vent	19
Length of femur	8.7
Length of tibia	10.6
Length of hind foot	13.1
Breadth between sacral processes	4.2

Two specimens in Museum Academy Philadelphia, from Tejon Pass, southern California, 3,388 feet above the sea. From Dr. A. L. Heermann.

Var. *laticeps* Cope.

Color much like that of var. Regilla from Fort Tejon; that is, a dark interocular triangle and numerous well-defined dorsal spots. The broad

head renders the proportions of form similar to those in *H. curta* from which there is some difficulty in distinguishing it. The latter may be known by the small size and lack of gular vesicle among the males. The muzzle is more obtuse than in the type of *H. cadaverina*, but one specimen of Laticeps is similar in this point; there is no labial brown border, but we have it much obscured in a Laticeps; the diameter of the eye is less, measuring less on the humerus; the digits much broader and shorter, with the largest pallets equaling the tympanum, while they are more elongate and slightly proportioned in Laticeps and Regilla vera. There is a thin tarsal ala, extending to the cuneiform bone, which is scarcely marked in the Laticeps. There are more lateral dorsal spots. These characters can not now be proven evanescent, so that this allied subspecies may be accepted.

	Lines.
Length from end of muzzle to vent	17.2
Length from end of muzzle to canthus ovis	5
Length of whole fore limb	10.4
Length of whole hind limb	25.6
Diameter of eye	2.2

No. 5308; Cape St. Lucas, Lower California; eight specimens; John Xantus.

Hyla regilla Baird.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3246	3	Fort Vancouver, Wash.		Dr. J. G. Cooper	Alcoholic.
3232	3	do		do	Do.
9181	4	Puget Sound, Alaska			Do.
9182	1	do		C. P. Expl. Exped	Do.
8512	1	Cerros Island, Lower Cal.		Dr. J. H. Streets, U. S. N.	Do.
3229	2	Yuba, Cal		Dr. C. G. Newberry	Do.
3253	1	Astoria, Oregon		Lieut. W. P. Trowbridge, U. S. A.	Do.
4552	3	Fort Umpqua, Oregon		Dr. E. Vollum, U. S. A.	Do.
3236	1	Shoalwater Bay, Wash.		Dr. J. G. Cooper	Do.
3250	1	Fort Dalles, Oregon		Dr. G. Suckley, U. S. A.	Do.
3240	5	do		do	Do.
3252	5	Puget Sound, Oregon		do	Do.
9424	1	Chilowyuck Lake, Oreg.		Dr. C. B. R. Kennerly	Do.
9449	1	California		Dr. J. G. Cooper	Do.
9500	2	Southern California	1875	H. W. Henshaw	Do.
8704	1	Los Angeles, Cal	July —, 1875	William Somers	Do.
8680	5	Santa Barbara, Cal	July —, 1875	H. W. Henshaw	Do.
8701	7	do	June —, 1875	do	Do.
8686	20	Santa Cruz Island, Cal.	June —, 1875	do	Do.
8702	1	Mount Whitney, Cal	Sept. —, 1875	do	Do.
8697	1	Mountains near Fort Tejon, Cal.	Aug. —, 1875	do	Do.
9499	5	Lake Tahoe, Nevada	Oct. 4, 1876	do	Do.
8682	22	do	Aug. —, 1876	do	Do.
8703	4	Fort Tejon, Cal	July —, 1875	do	Do.
4895	9	do		John Xantus	Do.
5293	19	do		do	Do.
3245	3	Monterey, Cal		Dr. G. Suckley, U. S. A.	Do.
9341	1	California	1877	L. Stone	Do.
8977	6	Puget Sound, Oregon	Aug. 11, 1872	Dr. C. B. R. Kennerly	Do.
3235	8	California		A. L. Heermann	Do.
11574	8	San Diego, Cal		Dr. John L. Le Conte	Do.
3242	6	Fort Dalles, Oregon		Dr. G. Suckley, U. S. A.	Do.
5932	3	Fort Crook, Cal*		John Fielner	Do.
11970	1	La Paz, Cal	1882	L. Belding	Do.
11969	1	do	1882	do	Do.
13796	1	Baird, Shasta County, Cal.	1884	C. H. Townsend	Do.

*Elevation, 2,937 feet.

Hyla regilla Barid—Continued.

GENERAL SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4568	21	Fort Tejon, Cal		J. Xantus	coholic.
9446	1	California		Dr. J. G. Cooper	Do.
5251	1	Fort Walla Walla, Wash.		Lieutenant Mullen	Do.
8686	46	Santa Cruz, Cal	June—, 1875	H. W. Henshaw	Do.
6929	4	Santa Barbara, Cal		Dr. Webb	Do.
3238	4	Fort Reading, Cal		Dr. Hammond	Do.
11940	3	Camp Bidwell, Cal	1878	H. W. Henshaw	Do.
11481	1	Ogden, Utah		Expl. W. 100th meridian.	Do.
9486	1	Monterey, Cal		W. H. Dall	Do.
9496	1	do		do	Do.
9491	1	Cottonwood Cañon		(?)	Do.
11529	1	Ringgold Barracks, Tex.		Dr. Webb	Do.
8844	1	Fauquier County, Va		C. W. Sheurmann	Do.
11522	4	Chewaukan Valley	1878	H. W. Henshaw	Do.
11944	1	Des Chutes River, Oreg.	1878	do	Do.
11123	12	(?)		(?)	Do.
8688	15	Santa Barbara, Cal		H. W. Henshaw	Do.
11947	2	Plumas County, Cal		G. Thompson	Do.

HYLA EXIMIA Baird.

Proceed. Ac. Phia., 1854, p. 60; U. S. Mex. Bound. Surv., II, Reptil., p. 29, Pl. XXXVIII, figs. 8-10; Peters Monatsber. Berl. Akad., 1869, p. 880; Brocchi, Bull. Soc. Philom., Paris (7), I, p. 128; Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882, 378.

Hyla euphorbiacea Günther, Cat. Batr. Sal. Brit. Mus., ed. I, 1856, p. 109, Pl. X, f. c.; Steindachner, Novara Amphib., p. 59.

Head small, width three and one-third times in total length; loreal region straight; canthus rostralis strong. Sacral diapophyses small, well dilated. Tympanum half orbit or a little less. Skin smooth above. Tibia not half the total length. Hind foot longer than arm from elbow, two and one-quarter to two and one-half times width of head behind. In spirits, bluish above, with or without two dark longitudinal stripes; beneath white. A dark band from the eye along the sides, margined above and below by a white line, the lower one reaching only to the arm, behind which the outline of the dark band is indistinct. Legs not banded.

The proportions of this species are much those of *H. squirella*, but stouter; the head short and broad, the body stout, and the limbs short. The skin above appears smooth, as in *H. carolinensis;* beneath granulated. The tongue is large, apparently broader than long; shape slightly emarginate behind; one-third free. Teeth are in two rather elongated patches, inclined from each other backwards between the internal nares, and terminating about opposite the centers of the latter; then more posterior than in *H. carolinensis.* Tympanum moderate. A single vesicle, supported between the rami of the lower jaw.

The fingers are provided with distinct pallettes and are very slightly webbed at base; the toes also with well-developed pallettes and webbed to their penultimate articulation (the antepenultimate is the longest toe). The tibia is longer than the thigh, but not half the length of the body.

Above of a nearly uniform clear bluish lead color in alcohol; no doubt green in life; beneath white or unicolored. A brown line extends

from the nostril to the eye, back of which it widens, involving the tympanum, and extends above the arm and along the side, fading out towards the groin; it is bordered above by a white margin, following it all the way from the eye; the upper edge not very clearly defined, especially behind, where it graduates into the blue of the back. The lower edge of the lateral vitta is margined by a distinct narrow white line (fading anterior to the eye into the blue), which margins the dark border of the upper jaw and extends to the insertion of the arm. The edge of the jaw is brown. Posterior to the fore legs the dark lateral stripe has its lower edge indistinct and fading through bluish white into the white of the belly. On each side of the back there is a narrow dark band, commencing opposite the fore-arm and extending to the inguinal region, the two parallel, and about as wide apart as are the orbits; they are margined by an indistinct border of lighter. Above the anus and bounding the back posteriorly is a series of six or eight white spots in contact with each other. There are no bands or blotches across the limbs, although on the outer edges (when the animal has all the limbs flexed) there is an indistinct brown line separated from the dorsal blue by bluish white.

Measurements of No. 3257 (♀).

	Lines.
Muzzle to vent	16.5
Muzzle to middle of tympanum	4.2
Breadth between orbits	2
Antebrachium and head	7.7
Femur from groin	5.2
Tibia	8.2
Foot	12.4

Measurements of No. 3248.

Total length	.81	1.00
Fore-arm and hand	.32	.39
Femur	.35	.43
Tibia	.37	.46
Tarsus	.21	.26
Foot	.34	.42
Total of hind leg	1.19	1.47

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3257	4	Valley of Mexico		John Potts	
3248	2	City of Mexico		Maj. W. Rich	
	11	Puebla Mexico		F. Sumichrast	

According to Sumichrast this species is found during the winter season in the vicinity of water, and has the habits of Lithodytes. I have found it near the water, in March, near the City of Mexico. It thus resembles its allies of North America proper, *Hyla regilla* and *H. pickeringii*.

HYLA SQUIRELLA Bosc.

Hyla squirella (Bosc.) in Sonnine & Latreille, Hist. Nat. Reptil., II (1802), 181 (Charleston, S. C.); (Bosc.) Daud., Hist. Nat. Reptil., VIII (1803), 34, XCIII, 2; Le Conte, Ann. N. Y. Lyc., I (1825), 279; Harlan, Journ. Ac. Nat. Sci. Phila., V (1827), 342, and Med. & Phys. Res. (1835), 107; Holbrook, N. Amer. Herp., 1st ed., I (1836), 105, XVIII, and 2d ed., IV (1842), 123, XXX; Storer, Rept. Mass. (1839), 242 (copied from Holbrook); Dum. & Bibr., Erp. Gén., VIII (1841), 587; ? De Kay, N. Y. Zool., III, Reptil. (1842), 72, XXI, 53; ? Thompson, Nat. Hist. Vt. (1842), 122; Le Conte, Proceed. Ac. Phila., 1855, p. 429; Günther, Cat. Batr. Sal. Brit. Mus., 1868, p. 11; Boulenger, 2d ed. Cat. Batr. Sal. Brit. Mus., 1882, p. 398.

La Raine squirelle Bosc., Nouv. Dict. d'hist. nat., XXVIII (1817), 543.

Hyla squirella Gravenhorst, Delicæ Mus. Vratislav. (1829), 28; VI, 1, does not belong to this species.

Calamita squirrella Merrem, Tentamen, p. 171.

Auletris squirella Wagler, Syst. Amph., p. 201.

Above smooth. Hind foot less than arm from elbow. Tibia about half the length of the body. Light brown above (green in life?), with small, rather subcircular blotches of darker. Legs rather indistinctly barred. Anterior and posterior faces of thighs without light spots of dark vermiculations. A dark line from snout to eye; a dark vitta from eye to arm through tympanum; edge of upper jaw mottled white, generally showing distinctly as a light line, which frequently extends to the middle of the side.

Body more slender than in *H. versicolor*. Limbs moderately developed. Eyes prominent. Snout rather acute. Tympanum small, half the diameter of the eye. Tongue rather small, nearly orbicular, hardly notched behind. Vomerine teeth in two small patches between the inner nares and nearly in line with their centers. Tibia not quite half the length of the body. No web at the base of the fingers.

Length of head a little more than three times in length. Heel of extended hind limb marking a point between orbit and end of muzzle.

The body above is smooth, beneath granulated on the abdomen and thighs. The toes are not webbed beyond the penultimate articulation of the third and fifth and the antepenultimate of the fourth toes.

Above green, sometimes with irregularly arranged darker small blotches. Beneath white. There is a V-mark connecting the eyes above, although this is not very distinct. A small number of subcircular blotches about the size of the tympanum, or larger, are sometimes scattered over the back, and may be of elongate form. There is a dark line from the nostril to the eye and a vitta from the eye through the tympanum to a point above the insertion of the arm. A narrow white line, rather indistinct, passes along the head very near to the edge of the upper jaw and below the tympanic vitta; this line rarely passes the arm; sometimes extends on the side, where it is generally very much confused. The upper faces of the leg are barred transversely, though generally not very distinctly, except across the tibia, where the bars are usually decided. The exterior edges of the feet are mottled finely with brown and gray. The anterior and posterior faces of the

thighs are dull flesh color, very faintly clouded with brown; no indications, however, of light spots or dark vermiculations.

Specimens differ in less amount of white on the jaw, and in tint of ground color, which is described as green in life. With a considerable resemblance to *H. femoralis*, it may be always distinguished by the white line along the edge of the mouth and by the absence of distinct circular white (yellow in life) spots on the posterior faces of the thighs.

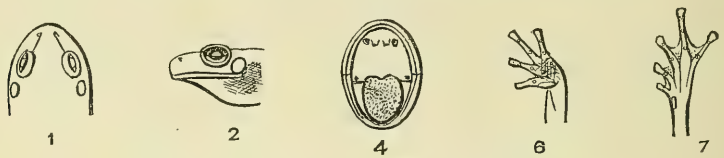


FIG. 90. *Hyla squirella*. No. 11911. Nashville, Ga.; ½.

Measurements of No. 12008.

	M.
Length of head and body	.030
Length of head to posterior edges of tympana	.010
Width of head at posterior edges of tympana	.0105
Length of fore limbs from axilla	.017
Length of hind limbs from groin	.0455
Length of tibia	.016
Length of tarsus	.009
Length of rest of foot	.012

The specimen measured is of full size. They are rarely larger, and frequently a little smaller.

This species approaches nearly some forms of *H. regilla*, of which it may be considered the southeastern representative, though the regions inhabited by both approach in Texas. It may be always distinguished by the more depressed head and weaker canthus rostralis; it is rarely so robust and usually of more delicate and less striped coloration. *H. miotympanum* Cope replaces it in Mexico; the resemblance between them is offset by the greater palmation and smaller tympanum of the latter. In its distribution this species extends well up the Mississippi valley. A specimen of larger than usual dimensions was sent me from near Brookville, Ind., by my friend Amos W. Butler.

Hyla squirella Bosc.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3650	5	Pensacola, Fla		Dr. W. A. Hammond, U. S. A.	Alcoholic.
3644	1			Prof. L. Agassiz	Do.
3645	2	Liberty County, Ga		Maj. J. Le Conte	Do.
3647	3	Grahamville, S. C		Bailey	Do.
9955	20	Little Sarasota Bay, Fla.	1875	Prof. F. B. Meek	Do.
4551	8	New Orleans, La		New Orleans Academy	Do.
5066	1	Micanopy, Fla		Dr. T. H. Bean	Do.
11911	1	Nashville, Ga	1880	W. J. Taylor	Do.
13479	7	Allapaha, Ga	1883	do	Do.
12008	6	Georgiana, Fla		William Wittfield	Do.
11510	1	(?)		(?)	Do.
10881	1	Oakley, S. C		T. W. Hayward	Do.
1131	1	Sonora		A. Schott	Do.

HYLA ANDERSONII Baird.

(Plate LXXIV; fig. 1.)

Proceed. Ac. Phila., 1854, p. 16; Cope, *l. c.*, 1862, p. 154; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 378.

In proportions and general appearance similar to the *Hyla arborea* of Europe. The skin of the upper surface of the body and extremities is smooth, minutely corrugated; that of the throat, belly, and under surfaces of the femora is areolated. A cutaneous fold across the breast and one across the throat. Tympanum about one-third the size of the eye. Tongue broad, slightly emarginate. Vomerine teeth in two oblique series between the internal nares, each directed inward and backward. The head is short and wide, and enters the length three and a quarter times. It is nearly a third wider than long. The muzzle is rounded when viewed from above, and in profile does not project, but rather slopes slightly forwards to the labial margin. The fingers are free, and the web of the toes leaves two phalanges free, except on the fourth toe, where it leaves three phalanges free. The four limbs are rather long; the hind limbs are moderate, the heel, when extended, reaching the middle of the orbit. The digital pallettes are small, not half the diameter of the tympanum. A tubercle on the under side near the proximal end of each phalange. Internal metatarsal tubercle distinct, oval; external, none.

Coloration in life. The whole upper a rather deep pea-green, paler upon the sides and the margin of the upper lip. A narrow band of purplish-brown commences at the external nares, passes through the eye, and, including the tympanum, loses its inferior border a little beyond the insertion of the humerus. The color becomes paler upon the sides, where it is of an ashy mulberry tint, and extends as far as the origin of the femur. Anterior to this point it is margined below by large irregular spots of a beautiful saffron, which are continued upon the anterior and posterior surfaces of the femur, and the whole inferior surface of the tibia, upon a ground of a paler shade of the same color. The superoanterior surface of the tarsus, the three inner toes, and the webs of the external, also a small area behind the humerus, the posterior surface of the latter, the inferoanterior face of the fore-arm, and the inner finger, are tinted and spotted in the same manner. The superior surfaces of the femur, tibia, humerus, and fore-arm are of the same color as the back; that of the humerus separated from the green of the jaws by an isthmus of the purplish shade, and that of the tibia separated anteriorly from the saffron of its lower surface by a band of mulberry. The green of the back and extremities is everywhere margined with pure white, except posteriorly on the femur and tibia, and anteriorly on the former, where saffron takes its place. The green crosses the rictus and forms an oval spot upon each side of the throat. The borders of the latter and of the chin are tinged with mulberry. Beneath whitish flesh color.

The exposed surfaces of the anterior and posterior extremities, where not green, are of a shade intermediate between mulberry and chocolate.

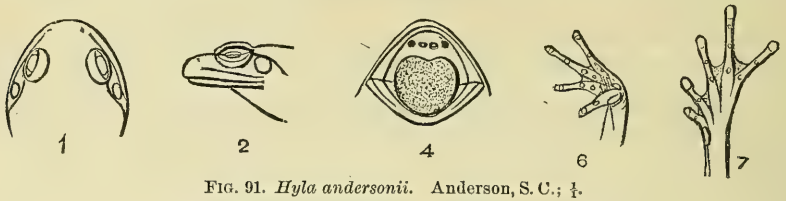


FIG. 91. *Hyla andersonii.* Anderson, S. C.; ½.

Measurements of No. 3600.

	M.
Total length head and body	.0366
Length of head to posterior line of tympana	.011
Width of head at posterior line of tympana	.015
Length of fore limb from axilla	.0224
Length of hind limb from groin	.0525
Length of tibia	.018
Length of tarsus	.010
Length of rest of foot	.0155

This beautiful species is of much rarity, but two specimens having thus far come under the eyes of naturalists. The longest known is the type from Anderson, S. C., which is represented in Plate LXXXIV; the second specimen was found by Professor Leidy, of Philadelphia, at Jackson, N. J., and was the subject of the description of coloration in life given above.

HYLA CAROLINENSIS Pennant.

(Plates 51, fig. 14; 72, fig. 19; 73, fig. 28.)

Calamita carolinensis Pennant, Arctic Zool., II (17), 331.
Calamita cinerea Schneider, Hist. Amph. Fasc., I (1799), 174.
Rana bilineata Shaw, Gen. Zool. Amph., III (1802), 136.
Hyla lateralis Daud. in Sonn. & Lat., Hist. Nat., Reptil., II (1802), 180; Daud., Hist. Nat., Reptil., VIII (1803), 27, and in Hist. Nat. Rain. Gren. Crap. (1803), 16, II; J. Le Conte, Ann. N. Y. Lyc., I (1825), 279; Harlan, Journ. Ac. Nat. Sci. Phila., V (1827), 341, and Med. & Phys. Res. (1835), 107; Dum. & Bibr., Erp. Gén., VIII (1841), 587.
Hyla viridis Holbrook, N. Am. Herp., 1st ed., II (1838), 95, XX, and 2d ed., IV (1842), 119, XXIX.
Hyla viridis arborea Catesby, Nat. Hist Carol., II (1743), pag. et tab. 71.
Hyla semifasciata Hallow., Proceed. Ac. Phila., 1856, p. 307.
Hyla carolinensis Günther, Cat. Batr. Sal. Brit. Mus., 1868, p. 105; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed. 1882, p. 377.

Head subacute; body slender, nearly smooth above; tibia rather more than half the length of the body; above and on sides uniform olive-green, with an occasional circular light spot above; beneath white. A distinct narrow white line along the sides of the head and body; similar lines on the outer edge of the fore-arm and hand, the posterior edge of the tibia, and the outer edge of the hind foot. No bars on the limbs.

Body slenderest of all the North American species; limbs elongated. Outline of head acute, angled, slightly curved on sides, rather longer than broad. Snout rather pointed; sides of the snout somewhat oblique; length of head entering total a little over three times. Tympanum small, about half the diameter of the eye, a fold of skin above it. Tongue rather ovate, slightly notched behind, where it is free for one-third its length. Vomerine protuberances small, rounded, their axis slightly inclined, almost exactly between the posterior nares; separated from each other and the nares by the same interval. The ranges of teeth are a little behind, about on a line with the posterior margins of the nares.

The extremities are rather slender and elongated. The heel of the extended hind legs marks the end of the muzzle. Tibia about half length of body; hind foot as long as arm from elbow; two and a half times in total length. The fingers are dilated at the tip into disks, two-thirds as large as the tympanum, and webbed at the base to the antepenultimate articulation of the longest. The third is longest, the fourth little shorter; then the second and first. The hind feet are webbed to the disks (the penultimate articulation in the fourth and longest toe), the web wanting on the inner side of the penultimate joint of the second and third. The third toe is a little longer than the fifth. There is a soft tubercle at base of inner toe and a very rudimentary one at base of outer.

The skin above and on upper part of sides is smooth, without any pustules; in larger specimen a faint and softened granulation; the belly and inferior face of thighs strongly granulated; the throat moderately so; smooth between the arms.

Color of body and legs above and sides olivaceous-brown or olive-green, with a few scattered, well-defined spots of white. Beneath white, no mottling anywhere. A well-defined line of white starts on the snout, generally united with its fellow on the opposite side, and passes backwards, parallel with the edge of the upper jaw, under the tympanum and over the arm-pit; extends half-way or more along the sides. It has as a border a deeper shade of the dorsal color. A similar line extends along the posterior margin of the fore legs, most conspicuous at the elbow, and reaches to the outer finger. On the hind leg a similar line passes from the knee, and extends along the posterior or superior margin of the tibia along the exterior edge of the tarsus and foot to the tip, and a second line is seen in some on the anterior margin of the tibia; a short transverse white line above the anus. According to Dr. Holbrook, this species in life is bright grass-green above, the light lines straw color.

Specimens from west of the Mississippi vary in appearing a little more granulated above. Some males exhibit a more or less tinge of green on the sides of the chin. Sometimes the lateral white line is interrupted, and those on the sides of the legs more or less obsolete.

The specimen described is from Riceborough, Ga.

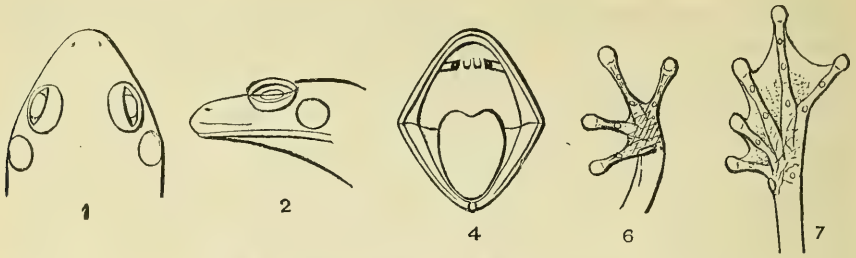


FIG. 92. *Hyla carolinensis.* No. 13478. Alapaha, Ga.; ½.

Measurements of No. 3652.

	M.
Length of head and body	.045
Length of head, including tympana	.014
Width of head at posterior edges of tympana	.013
Length of anterior limb from axilla	.023
Length of posterior limb from groin	.073
Length of tibia	.023
Length of tarsus	.0145
Length of rest of foot	.017

The specimen measured is only of medium size. They frequently reach a length of 58mm.

Hyla carolinensis Pennant.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3655	15	Pensacola, Fla		Dr. W. A. Hammond, U. S. A.	Alcoholic.
3652	2	Riceborough, Ga			Do.
3653	1	Mississippi		Dr. B. F. Shumard	Do.
6395	1	Beaufort, S. C			Do.
8969	1	Kinston, N. C		J. W. Milner	Do.
9708	1	Milledgeville, Ga	June 4, 1876	Kumlien & Bean	Do.
11495	15	Liberty County, Ga		Maj. J. Le Conte	Do.
3684	1	Georgia		C. B. Adams	Do.
5904	6	Liberty County, Ga		Maj. J. Le Conte	Do.
12006	2	Georgiana, Fla		William Wittfield	Do.
11483	1	(?)		(?)	Do.
11393	1	Milton, Fla	1881	S. T. Walker	Do.
11931	1	Marco Island, Fla		J. W. Velie	Do.
13478	2	Allapaha, Ga	1883	William J. Taylor	Do.
4558	2	Palatka, Fla		T. Glover	Do.
4719	12	Micanopy, Fla		Dr. T. H. Bean	Do.
1070	2	Saint Louis, Mo		Dr. George Engelmann	Do.
5204	2	Louisiana		Saint Charles College	Do.
3657	5	Prairie Mer Rouge, La		James Fairie	Do.
3651	1	Washington County, Miss.		Col. B. L. C. Wailes	Do.
3244	2	New Braunfels, Tex		F. Lindheimer	Do.
3258	3	San Antonio, Tex		J. H. Clark	Do.
3654	2	Pensacola, Fla		Dr. R. W. Jeffrey	Do.
4556	3	Grand Coteau, La		Saint Charles College	Do.
12005	6	Georgiana, Fla		William Wittfield	Do.
6395	2	Beaufort, S. C		Dr. F. V. Hayden	Do.

GENERAL SERIES.

12005	18	Georgiana, Fla		William Wittfield	Alcoholic.
5240	2	Pass Christian, Miss		Capt. R. Anderson	Do.

HYLA ARENICOLOR Cope.

Journ. Ac. Phila. (2), 1866, p. 84.

H. affinis Baird (non spixii), Proceed. Ac. Phila., 1854, 61; U. S. Mex. Bound. Surv., Reptil., p. 29, Pl. XXXVIII, figs. 4-7.
Hyla copii Boulanger Annals and Magazine Nat. History, 1887, p. 53; 1888, p. 189.

Head short, wide, entering the length three and a half times. Muzzle regularly broadly rounded, not projecting beyond premaxillary border, as long on the side as the length of the eye fissure. Nostrils terminal, near the superior plane of the muzzle. Tympanum very distinct, its diameter two-thirds that of the eye fissure. Tongue discoid, very openly emarginate behind. Choanæ small; the vomerine teeth in a pair of transverse fascicles exactly between them. Ostia pharyngea of Eustachian tubes about equal to the choanæ.

Integument with numerous scattered small tubercles, above and on the limbs. Gular region areolated, as well as belly. Fingers free, the first considerably shorter than the second. Pallettes moderate, one-third the area of the tympanum. Hind legs moderate; when extended, the heel marks the anterior part of the orbit. The extent of the web is somewhat variable, in some specimens leaving only two phalanges of the fourth toe free, while in others two are free on the outer side and three on the inner; while others display intermediate conditions. The pallettes are about the size of those of the hand. The internal metatarsal tubercle is small but distinct; a narrow tarsal fold, which is incurved proximally. The length of the arm from the elbow is less than that of the tibia, but is greater than the hind foot.

The general tint of color is much as in *H. versicolor*. The blotches on the back are, however, more numerous, and exhibit a tendency to arrangement in two rows of nearly circular spots; sometimes the serial arrangement is not maintained. Owing to the greater length of the hind legs, there are three transverse bars across the femur, tibia, and tarsus, as well as a larger number on the metatarsus. The marbling, so conspicuous on the anterior and posterior faces of the hind legs, as well as in the groin of *H. versicolor*, is here wanting.

General aspect of *H. versicolor*, having the same squat appearance, the granulated skin above and below, the ash-color back with darker mottlings, the white spot under the eye, etc. The most conspicuous distinctive features are the absence of webs of the fingers, the greater length of the hind legs, and the blotches on the back being in round spots, not cuneiform. The legs with three bars not two, and without the reticulate markings behind and below.

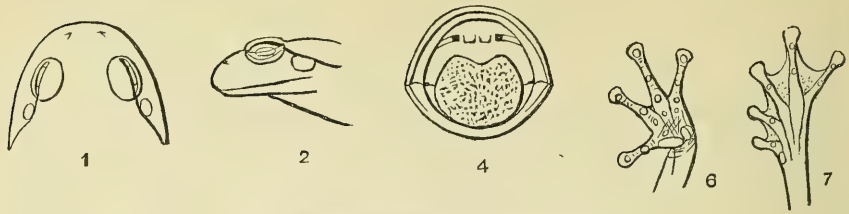


FIG. 93. *Hyla arenicolor*. No. 8656. Utah; ½.

Measurements of No. 11410.

	M.
Length of head and body	.042
Length of head, including tympana	.0123
Width of head, including tympana	.016
Length of fore limb from axilla	.0245
Length of hind limb from groin	.0592
Length of tibia	.020
Length of tarsus	.0115
Length of rest of foot	.0155

The specimen above described is one of types from Sonora. In specimens from some other parts of Mexico and the United States the white spot below the eye is not found. In a specimen from the Colorado River (4570) there are seven rows of dark brown spots of moderate size on the back. Specimens from El Paso, Texas, have been referred to as distinct species under the name of *H. copii*, by Dr. Boulanger (loc. cit.). The only peculiarity which the description indicates is a somewhat smaller tympanic drum. It is said to be one-half the eye at the first reference, and "hardly one-third" at the second.

The *Hyla arenicolor* is quite abundant as far south as Guanajuato, Mexico, where Dr. Alfredo Dugés has found it. This gentleman informs me that its voice is much like that of the bleating of goats.

Hyla arenicolor Cope.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
8550	1	Santa Fé, N. Mex	June —, 1873	Dr. O. Loew	Alcoholic.
8094	2	Southern California	1875	H. W. Henshaw	Do.
8656	1	Utah	1872	Dr. H. C. Yarrow	Do.
11411	5	Sonora, Mexico		J. H. Clark	Do.
4570	4	Upper Colorado River		B. Möllhausen	Do.
10197	1	White River Cañon, Arizona.		Dr. Burr	Do.
14404	1	Fort Wingate, N. Mex		Dr. R. W. Schufeldt, U. S. A.	Do.

HYLA FEMORALIS Latr.

Hyla femoralis Sonn. & Lat., Hist. Nat. Reptil., II (1802), 181; Daud., Hist. Nat. Reptil., VIII (1803), 32, XCIII, 1; Hist. Nat. Rain. Gren. Crap. (1803), III, 1; Le Conte, Ann. N. Y. Lyc., I (1825), 280; Harlan, Journ. Ac. Nat. Sci., Phila., V (1827), 342, and Med. & Phys. Res. (1835), 107; Holbrook, N. Amer. Herp., 2d ed., IV (1842), 127, XXXI; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 388.

La Raine femorale Bosc., Nouv. Dict. d'Hist. Nat., XXVIII, 543.

Calamita femoralis Merrem, Tentamen, p. 171.

Auletris femoralis Wagl., Syst. Amphib., p. 201.

Hyla squirella pars. Dum. & Bibr., Herp. Gén., VIII, p. 589; Günther, Cat. Batr. Sal. Brit. Mus., 1868, p. 111.

NOTE.—The descriptions of Daudin differ in some important points from the species of Major Le Conte.

Tibia less than half the length of body, longer than arm from elbow, which again exceeds hind foot. Skin nearly smooth above; above wood-brown, with a darker interocular, triangular blotch, and a subcuneiform one on the back, confluent in the center. A narrow line from the snout to the eye. A dark vitta from the eye, indistinct in the middle, passing through and involving the whole tympanum; the upper edge of this continued to the hind legs, the lower ceasing at the fore legs. Posterior face of the thighs dark brown, with circular yellowish-white spots. No light spot under the eye, nor any white line along the jaw; merely a lighter shade of the ground color.

Head broader than long. Body short, rather broad, and the entire appearance as to pattern of color and shape not very dissimilar from *Hyla versicolor*, from which, however, it is readily distinguishable by the femoral yellow spots; the dark postocular vitta, the absence of light spots under the eyes. The tongue is large, ovate, slightly notched, and free behind. The teeth are in two approximated minute circular patches between the posterior nares. The tympanum is small, scarcely more than half the diameter of the eye. The tibia is not half the length of the body. The skin above is slightly pustular, although at considerable intervals, and much less in proportion than *H. versicolor*. The whole inferior surface of the head, body, and thighs is granulated, including the throat. The pectoral fold of skin is smooth. The fingers are slightly webbed at the base, the fourth longer than second. The last two joints of the toes are free; the web not extending as a margin to the disk of the longest toe, as in *H. versicolor*.

General color above bark-brown, variegated with darker; beneath dull white. A triangular blotch between the eyes, the angle behind the anterior edge extending across between the middle of the edge of the upper eyelids. In *H. versicolor* this blotch is almost always interrupted in the median line. On the anterior half of the back is another large blotch, sending out two branches anteriorly and posteriorly, and one on each side, the anterior pair sometimes running into the blotch on the top of the head. Behind this are several other blotches of irreg-

ular shape, some of them confluent with that on the back. There is a narrow dark line extending from the snout through the nostril to the eye along the edge of the upper eyelid, and proceeding above the tympanum back along the side to the insertion of the hind leg. A second line extends from the lower part of the eye, parallel with the first, below the tympanum, and immediately above the insertion of the fore-arm. Perhaps it would be better to say that a broad dark band passes from the eye backwards through the tympanum, and over the insertion of the fore-arm, along the side of the body, where the lower edge is indistinct; the edges of the band are much the most prominent. There are two or three transverse bars on the fore-arm, the thigh, and leg, more numerous and closer on the tarsus and hind feet. The anterior face of the thigh is uniform dull white; the posterior, however, is dark brown, with several distinct, nearly circular spots of yellowish-white. The outer edge of the tarsus and hind foot is minutely punctate with gray and brown. The sides of the chin are dotted with brown. The extreme edge of the upper jaw is sometimes darker than the rest, with a slight shade of lighter color above it, very inconspicuous, however.

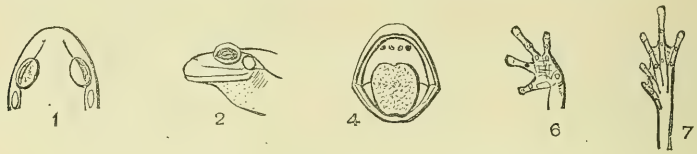


FIG. 94. *Hyla femoralis.* No. 3598. Liberty County, Ga.; ½.

Measurements of No. 5908.

	M.
Length of head and body	.0355
Length of head, including tympana	.0115
Width of head, including tympana	.0133
Length of fore limb from axilla	.0205
Length of hind limb from groin	.056
Length of tibia	.018
Length of tarsus	.011
Length of rest of foot	.015

The specimen measured is a little above average size, which is intermediate between the dimensions of the *H. squirella* and *H. versicolor.* A very large specimen in my collection from Dallas, Tex., measures .039[m] in length of head and body.

Hyla femoralis Daudin.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
5908	1	Riceborough, Ga		Maj. J. Le Conte	Alcoholic.
3599	2	do			Do.
3598	2	Liberty County, Ga		Maj. J. Le Conte	Do.
9697	2	Arlington, Fla	1878	G. Brown Goode	Do.
4718	2	Micanopy, Fla		Dr. T. H. Bean	Do.
14548	1	Goose Creek, S. C		(?)	Do.
13479	7	Allapaha, Ga		W. J. Taylor	Do.
11918	1	Nashville, Ga	1880	do	Do.

HYLA VERSICOLOR Le Conte.*

Hyla versicolor J. Le Conte, Ann. N. Y. Lyc., I (1825), 281; Harlan, Journ. Ac. Nat. Sci., Phila. V (1827), 343; Med. & Phys. Res. (1835), 108; Holbrook, N. Amer. Herp., 1st ed., I (1836), 101, XVII, and 2d ed., IV (1842), 115, XXVIII; Storer, Reptil. Mass. (1839), 241; Dum. & Bibr., Erp. Gén., VIII (1841); De Kay, N. Y. Zool., III, Reptil. (1842), 71, XXI, fig. 53 A; Thompson, Nat. Hist. Vt. (1842), 122; Günther, Cat. Batr. Sal. Brit. Mus., 1858, p. 103; Boulenger, *l. c.*, ed. 2, 1882, p. 372.

Dendrohyas versicolor Tschudi, Batrachia, p. 75.

Hyla richardi Baird, Proceed. Ac. Phila., 1854, p. 60 (young).

NOTE.—*Hyla verrucosa* Daud., Hist. Rain. Gren. Crap., 33, Pl. IV, is referred to this species by Dum. & Bibr. The description, however, applies equally well to several species, and in several points differs entirely from *H. versicolor*. The locality of *H. verrucosa* is unknown.

Male.—Body stout and clumsy. Head short, much broader than long; limbs short. Outline of lower jaw nearly semicircular; of upper, somewhat angulated. Tympanum rather large, about one-half the diameter of eye; a moderate fold of skin above it. Tongue large, nearly orbicular; notched behind, where it is free for half its length. Vomerine teeth in two transversely linear patches, extending between the posterior nares, with a slight interval between them, sometimes scarcely separating into two parts. Eyes large, protuberant.

The bases of the vomerine protuberances are in a line with the centers of the nares; the posterior edge of the teeth themselves a little behind the posterior margin of the nares. Eustachian apertures larger than the inner nares. No papilla behind the external nares.

Anterior limbs short, stout; fingers broad, dilated into broad disks; that on third finger nearly equal to the tympanum in diameter.

The web is more extended than in other species in the United States, in a female specimen leaving the two last joints only free. The disk of the inner finger is smaller than the rest. Tibia reaching half-way from the anus to the eye; longer than the hind feet, and equal to the arm from elbow. The heel of the extended hind leg reaches only to the posterior edge of the orbit. The third and fifth toes are nearly equal in length; the disks of the second and first are less developed than the rest.

In hind feet the membrane extends in a narrow margin all the way to the disks; membrane cut out along the two last joints of the longest toe and of the others along the inner edge, although specimens vary in the amount of this excision. All the fingers and toes are much depressed, and exhibit the Hyla character more than the other American species.

The entire animal is warty, or covered with coarse tubercles, with finer intermixed, except on the region of the loins and anterior and posterior faces of the thighs. Beneath, with distinct granules in a prominent and well-defined pavement; less conspicuous on the throat, neck, and palms. There is a very distinct and prominent fold of skin across the breast. The color is very variable with different specimens and circumstances. Above ash-gray, white, or brown. Above each

* Plate 64.

eye is an elongated blotch of dark brown, passing obliquely backwards towards its fellow, leaving a space between and forming an interrupted V. Posterior to these and in the anterior portion of the back is a single very large blotch, subcruciform in shape, from sending out a branch on each side towards the eye, more or less parallel with the blotches first mentioned. The posterior corners are also obliquely elongated to a greater or less extent. Immediately behind the large blotch may be usually traced two others, which are elongated, and extend obliquely to the sides of the body in a direction generally parallel with the outer edges of the dorsal blotch. A dusky, indistinct bar extends from the eye along the upper edge of the face through the nostril to the tip of the snout, and the edge of the upper jaw is more or less marbled with the ground colors. A conspicuous spot of light gray (with dark border) is always visible among other markings beneath the posterior half of the eye and on the posterior portion of the upper jaw; it is a little in advance of the tympanum and somewhat longer. A dusky, indistinct mottled band passes from the eye backwards through the tympanum along the side of the body, darkest along the undulating upper edge, where it is margined sometimes by yellowish-white. The fore-arm has two transverse dark bands; the thigh, leg, and tarsus each the same number. All the surfaces of limbs concealed when flexed are vermiculated with brown on a yellowish ground, the light intervals angular, even on the inside of tibia and foot. The anterior and posterior faces of the thigh and leg are yellow, sharply and narrowly marbled with brown. Beneath yellowish-white. Males, in spring, with the gular sac, mixed ash, brown, and white.

Specimen described from Grosse Isle, Mich.

The females differ mainly in the smaller tympani.

In other specimens, from Carlisle, Pa., there is evident a constant dark spot on the side of the upper jaw and beneath the anterior half of the eye, the light spot already described being situated between it and a narrow dark line in front of the tympanum. Sometimes the entire back, by the confluence of the blotches described, is occupied by a large mottled cross, the anterior fork very short. The anterior face of the arm is blotched with dark; the posterior marbled like the thigh. Sometimes the blotches are more or less obsolete; at others they are reduced in size, although usually cruciform in their arrangement. The color of the back is sometimes grass-green, with the dark blotches, which vary in extent.

In the southern and western specimens there is a tendency to a replacing of the brown reticulation on the yellow ground of the posterior face of the thighs by a number of subcircular golden spots in the brown ground, as in the *H. femoralis*, although northern specimens sometimes show traces of it. This is very evident in specimens from Prairie Mer Rouge and Tangipahoa River, Louisiana, and Dallas, Tex. As a general rule, too, the portions of the limbs concealed, or in contact with each other when flexed, are in northern specimens more fully marbled

with yellow and brown, even covering the whole inner face of the tibia, and the light interspaces more or less angular, while in the *Smilisca baudinii* and the southern and western specimens of *H. versicolor* the amount of marbling is less, and the interspaces are often reduced to small circular spots. I have, however, been unable to characterize them as more than a variety, to which I have given the name of *H. v. chrysoscelis.**

A single specimen of a strongly marked variety of this species was sent to the National Museum from Mount Carmel, Ill., by Lucien M. Turner (No. 12074). It is smaller, having the average dimensions of *H. femoralis*. The color is a dark brown, with three rows of large approximated darker brown spots. The groin and concealed faces of the thigh are yellowish-brown, with a very scanty speckling of darker brown, very different from the usual coarse netted pattern. At first sight one suspects this to be a specimen of *Hyla femoralis*, but it possesses all the essential characters of the integument and feet of the *H. versicolor*, as pointed out in the analytical table of the genus, including also the light spot under the eye. It may be called *H. v. phæocrypta.*

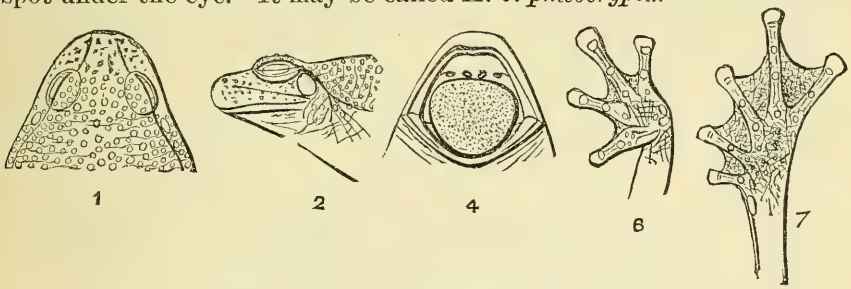


FIG. 95. *Hyla versicolor.* No. 14551. Rochester, N. Y.; ½.

Measurements of No. 3636.	*M.*
Length of head and body	.036
Length of head, including tympana	.016
Width of head, including tympana	.0213
Length of fore leg from axilla	.034
Length of hind leg from groin	.0813
Length of tibia	.026
Length of tarsus	.0155
Length of rest of hind foot	.0245

The *Hyla versicolor* is "the tree frog," par excellence, of the eastern and northern United States. It is common, and in some places abundant. Its voice is a loud, coarse, resonant trill, uttered with a uniform pitch, and continued for two or three seconds. It is heard about bodies of water in the spring, when the sexes are depositing and fertilizing the eggs. Later in the season it proceeds from fences, hedgerows, and orchards, as well as from the forest, often at no great elevation above the ground. They are especially noisy towards evening after a rain; but they may be heard at any time during dark and drizzly days. They are susceptible of some domestication. Mr. Jacob Geismar tells me

* Bulletin U. S. National Museum, No. 20, 1880, p. 20.

that he kept a number of them in a vivarium near a window. Both were left open during part of the day, and the Hylæ would leave the house and establish themselves on the trees in the orchard, where their voices were heard throughout the evening. During the night they would return to the house, and would appear in their usual place in the vivarium in the morning.

Their eggs are laid in small packets on blades of grass, slender sticks, etc., in shallow ponds and pools. The metamorphosis takes place while yet small, the young exceeding only a little those of the northern toad, *Bufo lentiginosus americanus*. Some of the larval stages are represented on Plate 76, figs. 23–6.

The *Hyla versicolor* was named as an expression of its striking power of metachrosis. It readily takes the color of the object on which it rests, thus concealing itself successfully. Its colors vary from a deep brown to gray, and nearly white to bright green. The change of color is not rapidly accomplished. The favorite color is gray, which is identical with that of the lichens of the trees which it inhabits. Professor Verrill records this species as being found at Norway, Me., the most east ern locality known to me.

Hyla versicolor Le Conte.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3637	8	Prairie Mer Rouge, La		James Fairie	Alcoholic.
3635	1	Anderson, S. C		Miss C. Paine	Do.
3639	1	Kemper County, Miss		D. C. Lloyd	Do.
3643	1	Ann Arbor, Mich		Prof. S. F. Baird	Do.
3642	1	Grosse Isle, Mich		Rev. C. Fox	Do.
3628	1	Racine, Wis		Dr. P. R. Hoy	Do.
3638	3	Columbus, Ohio		Prof. L. Lesquereux	Do.
4892	1	Green Plains, N. C		G. F. Moore	Do.
4831	3	Brookville, Ga		Dr. W. A. Hammond, U. S. A.	Do.
3643	1	Mount Holly, N. J			Do.
3626	1	Eutaw, Ala		Prof. A. Winchell	Do.
3641	2	Westport, N. Y		Prof. S. F. Baird	Do.
3234	2	New Braunfels, Tex		F. Lindheimer	Do.
3632	2	Aux Plaines River, Ill		R. Kennicott	Do.
5957	1				Do.
3636	6	Carlisle, Pa		Prof. S. F. Baird	Do.
3627	1	Washington, D. C		do	Do.
5017	1	South Carolina			Do.
3680	1	Tarborough, N. C		J. L. Bridger	Do.
4557	1	Maryland		C. B. Adams	Do.
3665	3	Wethersfield, Conn		C. Wright	Do.
3670	3	Meadville, Pa		J. F. Thicktstun	Do.
3669	1	Southern Illinois		R. Kennicott	Do.
4555	1	Washington, D. C			Do.
3667	1	Saint Louis, Mo		Dr. G. Engelmann	Do.
3671	1	West Philadelphia, Pa		W. S. Wood	Do.
4554	4	Saint Catherine, Ga		Dr. D. W. Beadle	Do.
3679	2	North Red River		R. Kennicott	Do.
3660	1	Natchez, Miss.		Col. B. C. L. Wailes	Do.
3663	2	Roan County, Tenn		Professor Mitchell	Do.
5191	1	New Orleans, La		Saint Charles College	Do.
9457	1	Goldsborough, N. C			Do.
8861	1	Tangipahoa River, La	Aug. —, 1875	Fred. Mather	Do.
8860	2	Claiborne County, Tenn		J. N. B. Scarborough	Do.
6454	1	Memphis, Tenn		Dr. John N. Woodworth	Do.
11434	1	Potomac River, D. C		George Shoemaker	Do.
7819	5	Washington, D. C		Dr. E. Coues, U. S. A	Do.
9671	1	Goldsborough, N. C		J. W. Milner	Do.
2560	1	Southern Illinois		R. Kennicott	Do.
3634	1	Mount Holly, N. J		Prof. S. F. Baird	Do.
9987	4	Springfield, Mass	1871	Wesleyan University	Do.

Hyla versicolor Le Conte—Continued.

GENERAL SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
5220	1	Alabama		W. M. Stewart	Alcoholic.
4561	1	Grand Coteau, La		Charles Cole	Do.
4560	3	New Orleans Academy, La.			Do.
4553	8	Pearl River, Miss		Miss Helen Tunnison	Do.
3662	1	Cook County, Ill		R. Kennicott	Do.
3683	1	Anderson, S. C		Mrs. M. C. Daniel	Do.
3668	1	Du Quesne, Ill		R. Kennicott	Do.
3658	1	Summerville, S. C		J. C. McNair	Do.
3681	2	Salem, N. C		J. T. Lineback	Do.
3682	1	Union County, Wis		Dr. P. R. Hoy	Do.
3247	1	Saint Louis, Mo		W. S. Wood	Do.
3260	2	Columbus, Ga		Dr. Gesner	Do.
9431	1	(?)			Do.
9507	3	Southern States			Do.
9394	9	Liberty County, Ga		Maj. J. Le Conte	Do.
9275	3	Virginia	1874	L. Stone	Do.
11533	1	Baraboo, Wis	1880	J. W. Wood	Do.
11480	1	(?)		(?)	Do.
11828	3	Old Fort Cobb, Cal		Dr. E. Palmer	Do.
3453	1	Saint Louis, Mo		Dr. George Engelmann	Do.
12571	1	Willoughby Point, Va		Earll & McDonald	Do.
11517	1	(?)		(?)	Do.
12078	3	Mount Carmel, Ill		Lucien M. Turner	Do.
7052	2	Goose Creek, S. C		(?)	Do.
3631	14	Cook County, Ill		R. Kennicott	Do.
5203	1	Grand Coteau, La		Saint Charles College	Do.
14174	2	Olney, Ill		John and Chas. Walker	Do.
	1				Do.
13326	2	Washington, D. C		George Shoemaker	Do.
14521	1	Gainesville, Tex	1885	G. H. Ragsdale	Do.
14522	2	do	1885	do	Do.
12674	1	Mount Carmel, Ill		L. M. Turner	Do.
4731	1	Washington, D. C		Megatherium	Do.

HYLA GRATIOSA Le Conte.

(Plate 49, fig. 9; 72, fig. 10.)

Proceed. Ac. Phila., 1856, p. 146.

Epedaphus gratiosus Lec., Cope, Proceed. Amer. Philosoph. Soc., 1885, p. 383.

This is the largest Hyla of the Nearctic realm. It conforms in shape to the typical forms of the genus, as the *H. versicolor*, *H. marmorata*, etc.; but it differs from other known species in one marked peculiarity: The peculiar glandular areolation of the integument of the belly in all Hylidæ is here seen on the dorsal region also. On this account I proposed the reference of the *H. gratiosa* to another genus, which I called Epedaphus. It remains to be seen whether this course is defensible or not.

The general characteristics of this species are as follows:

Web between outer fingers extending to end of proximal phalange. Head short, elevated. Tympanum half to two-thirds eye. Integument of upper surfaces with areolations similar to those of the abdomen. Toes webbed to base of penultimate phalange. Femora unicolor posteriorly. Upper lip narrowly dark edged, with a white line above the

border, sometimes continued as a lateral stripe. Above purplish-ash, with numerous dark spots, and often sparse yellow ones; side often reticulated with yellow; tarsus and antebrachium bordered with spots of the same.

The head is short, obtuse, elevated, the muzzle slightly prominent above the labial border, and sloping gently to the nearly plane front. Canthus rostralis obtuse; loreal region oblique. Vomerine teeth in two transverse contiguous fasciculi entirely between the inner nares. A dermal fold over the tympanum and one across the pectoral region. Vocal sac well developed. Hand large, as are all the terminal dilatations. The anterior are two-thirds the diameter of the membranum tympani, and the posterior are a little smaller The tympanum is very distinct, perfectly round, and with the diameter two-thirds that of the eye. The eye is rather small.

The cuneiform bone of the metatarsus is unusually prominent and the tarsal fold distinct and infolded. The labial border marks the middle of the antebrachium of the extended fore limb and the last third of the tarsus of the posterior.

The heel of the extended hind leg marks either the middle or front of the orbit.

The breadth of the cranium is contained two and two-thirds times in the total length, and the length three and a half times. The length of the tibia enters the same two and one-third times. The o. o. prefrontalia are not very widely separated anteriorly, nor are they produced beyond the line of the nostrils, and their inner anterior borders are nearly parallel; but they diverge almost transversely, and become regularly narrower posteriorly. The form of the xiphisternum is flat-urceolate; the proximal margin truncate, and the distal convexity interrupted by a deep rounded emargination.

The dark spots which cover all the upper surfaces may be absent, or so small as to give a speckled pattern, or so large as to present a reticulation of the ground. The very narrow labial stripe may be continued into a band or coarse yellow reticulations on the side. The groin and lower surfaces are yellow, except the gular region, which is purplish-ash, with or without a large subtriangular yellow mental area. The limbs all dark banded, the tibia bluish on the outer side; the femur uniform yellow posteriorly.

The young of this species resemble the *H. squirella;* but the shorter heavier head and muzzle, and more obtuse canthus rostralis, the traces of areolation on the dorsal skin, and the yellow borders of the antebrachium and tarsus distinguish it. Specimens an inch and a quarter in length have not yet developed the dark cross-bands of the extremities; in many of an inch, dorsal spots are invisible, and the areolations have not appeared. As is always the case with young frogs, the extremities are relatively longer.

This beautiful species readily changes its color from green to brownish, according to Le Conte. Its range is restricted to Florida and ad-

jacent parts of Georgia. A specimen from Georgiana, Fla., is of a uniform green above, and resembles a very large *H. squirella* in color.

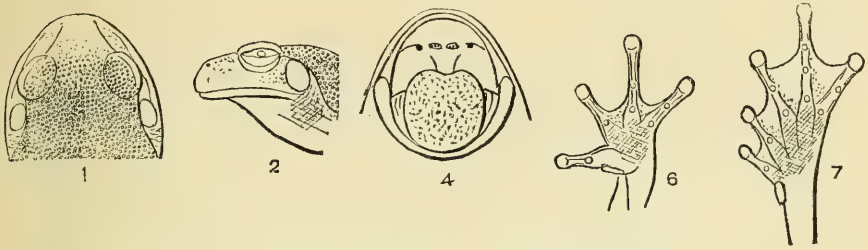


FIG. 96. *Hylà gratiosa.* No. 3684. Georgia, C. B. Adams; ½.

Measurements.	*M.*
From end of muzzle to canthus oris	.017
From end of muzzle to vent	.061
Length of head, including tympana	.018
Width of head, including tympana	.024
Width of sacral diapophyses	.013
Length of fore limb from axilla	.0395
Length of hind limb from groin	.086
Length of tibia	.027
Length of tarsus	.016
Length of rest of foot	.027

Hyla gratiosa Le Conte.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3675	2	Saint Augustine, Fla		E. R. Smith	Alcoholic.
4742	10	Micanopy, Fla		Dr. T. H. Bean	Do.
5901	7	Riceborough, Ga		Maj. J. Le Conte	Do.
3684	1	Georgia		C. B. Adams	Do.
	1	Georgiana, Fla		W. Wittemore	Do.

SMILISCA Cope.

Cope Proceed. Ac. Phila., 1865, p. 194; Journ. Ac. Phila. (2), VI, 1866, p. 85.

Acrodytes Cope, Nat. Hist. Rev., 1865, p. 109.

But one species of this genus is known. It is characteristic of the Mexican region of the Nearctic realm, but is found rather commonly within our borders in Texas.

SMILISCA BAUDINII D. & B.

(Plate 72, fig. 16.)

Hyla baudinii Dum & Bibr., Erp. Gén., VIII, p. 564; Boulenger Cat. Batr. Sal. Brit. Mus., ed. II, 1882, p. 371.

Hyla vanvlictii Baird, Proceed. Ac. Phila., 1854, p. 61.

Hyla muricolor Cope, *l. c.*, 1862, p. 359.

Hyla pansosana Brocchi, Miss. Sci. Mexique Batrachus, p. 125; teste Boulenger.

Smilisca daulinia Cope, Proceed. Ac. Phila., 1865, p. 194.

Somewhat similar in general appearance and markings to *H. versicolor*, although more slender, much smoother, and limbs more elongated. It is one of the larger species.

The tympanum is very large and distinct, nearly equaling the eye in diameter, and having a slight fold of skin above it. The head is narrower, more pointed, and more deeply cleft than in *H. versicolor;* the snout in front of the eyes longer. The tongue is subovate, less free behind than in *H. versicolor*, and scarcely notched. The posterior nares are larger and nearer together; they are larger than the Eustachian apertures, which are rather linear; the patches of teeth are very small. The skin above is nearly smooth, little less so than in large specimens of *Hyla carolinensis.* Beneath, however, the granulation is much as in *H. versicolor.* The webbing of the feet is much as in *H. versicolor;* heel to nares and end of muzzle.

Above, ash-gray. A rather broad dark bar passes backwards and inwards from above each eye, the two meeting in the middle. Behind this is an irregular cross, with broad branches, forming acute angles before and behind, the anterior extremities shorter and running into the obtuse V-shaped bar between the eyes. Two blotches behind the extremities of the posterior branches, as described in *H. versicolor*, and often confluent with them. The thighs and legs are each barred transversely with three bands; those on the hind feet are not distinctly to be made out. On the upper jaw there is a distinct grayish-white spot under the posterior half of the eye about the size of the tympanum. Behind the tympanum, and extending on the base of the arm above, is also a white blotch. The sides are yellowish-white, vermiculated sparsely with black, which color is concentrated on and under the scapular folds, so as to form a very conspicuous black spot. The posterior faces of the thigh brown, with yellowish-white spots, not vermiculated, as in the northern specimens of *H. versicolor.* Whole lower surface dull white.

Agrees with *H. arenicolor* (Sonora) in length of hind limbs and smaller fore-arm, but differs in being much smoother and larger; in the subcruciform dorsal blotch; black spot over fore-arm; vermiculated or reticulated thighs and side, still larger tympanum, etc.

	Inches.	
Total length	24	1.00
Head, length	7½	.31
Head, width	9	.37
Fore-arm and hand from elbow	12	.50
Thigh	12¼	.51

	Inches.	
Leg	12½	.52
Tarsus	7½	.31
Hind foot	10	.41
Total hind leg	40	1.61

Nearctic localities.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
	1	Brownsville, Tex		Capt. Stewart Van Vliet	
	1	Mouth of Rio Grande		I. H. Clark	
3259	1	Helotes, Tex		G. W. Marnock	

Neotropical localities.

	1	Mirador, Vera Cruz		Dr. C. Sartorius	
	2	Orizaba, East Mexico		V. Sumichrast	
	1	Guadalaxara, West Mex		T. T. Major	
	1	Colima, West Mexico		John Xantus	
	1	Omoa, Honduras		Dr. J. L. Le Conte	
	5	Yucatan		Arthur Schott	

AMPHIGNATHODONTIDÆ.

Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882, p. 449.

But two genera of this family are known, as follows:

Digits with large dilatations on the extremities; a dorsal dermal pouch; *Amphignathodon* Boul.

Digits acute at end; no dorsal pouch ..... *Grypiscus** Cope.

The typical genus is hylæform, while Grypiscus is a robust terrestrial type. The true position of the latter being somewhat doubtful, I give the following more exact definition:

Mandible with a series of caducous pleurodont teeth, and a permanent elevated tooth on each side the symphysis. Prefrontal bones fully developed, in contact with each other throughout, and with frontoparietals. Auditory apparatus well developed; tongue broad, entire, little free. Vomerine teeth; no parotoid glands. (See Plate 68, fig. 11.)

The mandibular teeth are obtuse, and scarcely project above the alveolar margin; their attachment appears to be to the mucous membrane only, on which account they are readily scraped away.

The affinities of this genus are as yet obscure; the mandibular teeth and general form would refer it to the Hemiphractidæ, but the form of the sacrum separates it. The form of the cranium, with its broad outline and narrow brain-case, and of the body in general, are nearest to Cyclorhamphus and Cophæus, though the form of the sacrum separates it again. If referred to the Pelodytidæ, it will be the type of a group in the family characterized as follows:

Frontoparietal bones fully developed; xiphisternum an emarginate, cartilaginous shield; coccygeal style attached to two condyles; toes webbed.

*A figure of *Grypiscus umbrinus* will be found in the Addenda.

HEMIPHRACTIDÆ.*

Cope, Journ. Ac. Phila. (2), VI., 1866; Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882, p. 451.

Three genera represent this family, as follows:

Vomerine, no parasphenoid teeth; ungual phalanges acute ..... *Hemiphractus* Wagl.
Vomerine, no parasphenoid teeth; ungual phalanges dilated .... *Ceratohyla* Espada.
Vomerine and parasphenoid teeth; ungual phalanges dilated..... *Amphodus* Peters.

The species of these genera are distributed as follows; all are of the Neotropical realm.

Hemiphractus, two species, Colombian region.
Ceratohyla, five species, Colombian region.
Amphodus, one species, eastern region.

GASTRECHMIA Cope.

Journ. Ac. Phila., 1867, p. 198.

But one family of this superfamily is known, and that embraces but a single genus. Its range is the Ethiopian realm.

Maxillæ edentulous; vertebræ procœlian; sacrum with dilated diapophyses, attached by condyles to a simple urostyle ..... *Hemisidæ.*

HEMISIDÆ.

Auditory apparatus wanting; tongue posteriorly retractile into a sheath; frontoparietal and prefrontal bones fully developed, the former coössified, the latter separated to end of muzzle by ossified ethmoid septum; toes webbed, no cuneiform shovel; no parotoid glands; manubrium present ..... *Hemisus* Gthr.

HEMISUS Günther.†

Cat. Brit. Mus., 1858.

Cacophrynus Steindachner.

This genus shows its nearest affines to be Callula and allied genera of the Engystomidæ in the wide separation of the lobes of the liver for the accommodation of the pericardial sac and its contents, and by the posterior position of the heart. In the latter point it exceeds all other genera; the heart is of relatively large size, and occupies nearly the median portion of the abdominal region. It would appear to be for the protection of this important organ that the coracoids are extended backwards. The cavity anterior to the heart is occupied by longitudinal muscles and the large larynx. The lobes of the liver extend each to the groin, a position even more posterior than in those genera of Raniformia which are characterized by the posterior position of that organ; and by the disappearance of its median lobe, and the wide separation of its lateral lobes for the accommodation of the heart. The genera in which this relation exists, are Breviceps, Engystoma, Systoma, Callula, Phrynomantis, Atelopus, and Pipa.

* Plate 73. † Plates 74, 76.

This genus exhibits also an external corpus adiposum, which I have not found in Callula, Engystoma, or any other genus of Batrachia. Each one is subtrihedral, the apex resting near the extremity of the coracoid, the body lying between the strata of the external and internal oblique muscles, along the anterior margin of the lobe of the liver on each side.

There are some important skeletal characters found in this genus, whose value is not yet clear. Thus the suspensorium is free, and has an antero-posterior movement on the proötic. This is due to the form of the squamosal, which has no zygomatic process, and is not united by suture with the proötic. The quadrate cartilage is all that connects it with the cranium. A similar structure exists in Breviceps and Callula (Plate 75, figs. 1–2). The frontoparietals are coössified with each other, as are also the prefrontals.

The hyoid apparatus is peculiar (Plate 56, fig. 18). The fourth ceratobranchials are ossified and proximally incurved, and in close contact with each other, thus surrounding the larynx in front. They are only connected with the basihyobranchial plate by membrane. The latter has a recurved transverse anterior margin, and sends a process forwards on each side to the incurved and thin ceratohyals. The third ceratobranchials are elongate and ossified distally. This kind of hyoid apparatus further distinguishes the family Hemisidæ from all others.

FIRMISTERNIA.

Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882 (minus Gastrechmia); Firmisternia and Raniformia, Cope, Check-List N. Amer. Batr., Reptil., 1877; Raniformia and Bufoniformia pt., Cope, Nat. Hist. Rev., 1865.

The families of this superfamily are the following:

I. No teeth on the maxillary or premaxillary bones:
- Præcoracoidei present; sacrum with dilated triangular diapophyses, confluent with coccygeal style; two lobes of the liver ..... *Brevicipitidæ.*
- Præcoracoidei wanting; sacrum distinct from coccygeal style, with dilated triangular diapophyses; two lobes of the liver ..... *Engystomidæ.*
- Præcoracoidei present; sacrum distinct from coccygeal style, with dilated triangular diapophyses; two or three lobes of the liver ..... *Phryniscidæ.*
- Præcoracoidei present; sacrum distinct from coccygeal style, with cylindrical diapophyses; three lobes of the liver ..... *Dendrobatidæ.*

II. Maxillary and premaxillary bones toothed:
- Præcoracoidei absent; sacral diapophyses dilated; mandible edentulous ..... *Cophylidæ.*
- Præcoracoids present; sacral diapophyses expanded; mandible edentulous ..... *Dyscophidæ.*
- Præcoracoid present; sternum and omosternum wanting; three lobes of the liver; mandible edentulous ..... *Colostethidæ.*
- Præcoracoid present; sternum and omosternum present, osseous; three lobes of the liver; mandible edentulous ..... *Ranidæ,*
- Præcoracoid present; sternum styloid; sacral diapophyses cylindric; mandible dentigerous ..... *Ceratobatrachidæ.*

This tribe belongs, par excellence, to the Old World. Two of the families, which include but few species, belong to the New, viz, the Dendrobatidæ and the Colostethidæ, and a few species of the Engystomidæ and Phryniscidæ also occur in tropical America. The Ranidæ have a number of representatives in North America. The Cophylidæ and Dyscophidæ exist only in Madagascar, excepting one species of the latter in India. The geographical distribution of the families is as follows:

	Australian.	Neotropical.	Nearctic.	Ethiopian.	Palæarctic.	Palæotropical.
Brevicipitidæ, species				4		
Engystomidæ		4	1			16
Phryniscidæ	1	19				5
Dendrobatidæ		8		4		
Cophylidæ				2		
Dyscophidæ				7		1
Colostethidæ		1				
Ranidæ	4	9	13	95	11	111
Ceratobatrachidæ	1					

The resemblance to the Neotropical fauna displayed by Madagascar in its lizards and snakes is also seen in the Batrachia in the presence of a genus and four species of the family Dendrobatidæ.

*BREVICIPITIDÆ.**

Cope, Journ. Ac. Phila., 1867, p. 191.

I. Prefrontals widely separated; ethmoid arch not ossified.
A frontoparietal fontanelle; ear perfectly developed; toes free; no parotoid glands; head not distinct from body; no vomerine teeth.. *Breviceps* Merrem.
Vomerine teeth present ..... *Rhombophryne* Bœttger.

The characters of Rhombophryne are so far unknown that its pertinence to the family Brevicipitidæ is entirely uncertain, nor is it known to possess the characters of Division A. The species of Brevicipitidæ are Ethiopian.

*ENGYSTOMIDÆ.**

Cope, Journ. Ac. Phila., 1867, p. 191.

I. Ethmoid arch not ossified; prefrontals widely separated.
A. A frontoparietal fontanelle; terminal phalanges with transverse limb.
Ear perfectly developed; toes free; no metatarsal shovel
..... *Phrynomantis* Peters.
II. Ethmoid arch ossified; prefrontals fully developed, in contact with each other and frontoparietals; latter complete.
A. Terminal phalanges with transverse limb, anteriorly at least.
"No tympanum or cavum tympani; Eustachian ostia minute"; toes webbed; no palatine teeth; subdigital parts small, simple.... *Microhyla* Tschudi.
Pupil horizontal; no vomerine teeth; toes webbed; subdigital tubercles of manus large, forming adhesive pallets..... *Phrynella* Blgr.
Tympanum, cavum tympani, and Eustachian ostia; toes with web or its rudiment; no palatine teeth..... *Callula* Gray.
Tympanum present; toes free; palate with a large curved tooth on each side ..... *Xenobatrachus* Peters & Doria.

* Plate 74.

AA. Terminal phalanges simple.

Pupil erect; palatine teeth normal; toes free; extremities enlarged ..... *Callulops* Blgr.

Pupil horizontal; tongue free behind; no vomerine teeth; fingers and toes free ..... *Cacosternum* Blgr.

Ear fully developed; head not distinct; membranum tympani concealed; toes free to slightly palmate; metatarsus with insignificant tubercles ..... *Engystoma* Fitz.

"Ear developed, membranum tympani concealed; toes free to partially palmate; metatarsus with two compressed shovel-like tubercles" ..... *Cacopus** Gthr.

"Ear developed, membranum tympani distinct externally; toes free; metatarsus with insignificant tubercles" ..... *Adenomera* Steind.

The species of this family are distributed as follows:

	Australian.	Neotropical	Nearctic.	Ethiopian.	Palæotropical.
Phrynomantis				2	1
Microhyla					5
Phrynella					1
Callula					7
Xenobatrachus	1				
Callulops				1	
Cacosternum	1				
Engystoma		7	1		
Cacopus					3
Adenomera		1			
	2	8	1	3	17

ENGYSTOMA Fitzinger.

N. Class. Reptil., p. 65; Günth. Cat., p. 51; Boulenger, Cat. Batr. Sal. Brit. Mus., 2d ed., 1882, p. 160.

Microps Wagl., Isis, 1828, p. 744, and Syst. Amph., p. 200.

Stenocephalus Tschudi, Batr., p. 86.

Engystoma, sp., Dum. & Bibr., VIII, p. 738; Cope, Journ. Ac. Phila. (2), VI, 1867, p. 194.

Systoma, sp., Cope, *l. c.*

ENGYSTOMA CAROLINENSE Holbrook.

N. Amer. Herp., I, p. 83, Pl. 2; Dum. & Bibr., p. 743; Hallow., Proceed. Ac. Phila., 1856, p. 251; Günth., Cat., ed. I, p. 51; Boul., Cat. Batr. Sal. Brit. Mus., 1882, p. 162.

Engystoma olivaceum Hallow., *l. c.*

Engystoma texense Girard, Proceed. Ac. Phila., 1859, p. 169.

Snout rather obtuse, slightly projecting, not twice as long as the diameter of the eye. Fore limb considerably longer than its distance from the tip of the snout; the hind limb being carried forwards along the body, the tibio-tarsal articulation reaches the shoulder in the female, a little beyond in the male. Toes quite free, with blunt tips and distinct subarticular tubercles; a very small inner metatarsal tubercle; no outer tubercle. Skin smooth; a fold across the head behind the eyes, which is, however, not unfrequently wanting in alcoholic speci-

* Including Glyphoglossus Gthr.

mens. Tympanic membrane concealed; ostia pharyngea smaller than choanæ.

Measurements of No. 9396.

	M.
Length of head and body	.0244
Length of head to rictus oris	.0055
Width of head at rictus oris	.0075
Length of fore leg from axilla	.012
Length of hind leg from groin	.028
Length of tibia	.0092
Length of tarsus	.006
Length of remainder of foot	.0113

The color of the head is chestnut above, and it is thickly mottled with blackish specks beneath. The upper jaw is dark brown and the lower is dark gray. The iris is very dark gray. The body is dark brown along the vertebral line and is chestnut on either side of it; the sides of the head and neck below the orbits and the flanks are grayish; the throat and abdomen lighter, all thickly sprinkled with blackish specks.

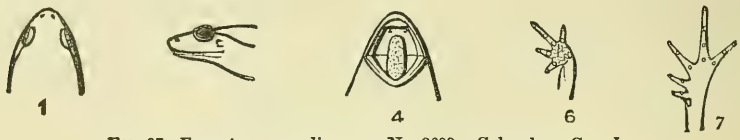


FIG. 97. *Engystoma carolinense*. No. 3699. Columbus, Ga.; ½.

The anterior extremities are chestnut-brown above and yellowish-brown beneath. The posterior extremities are chestnut-brown above, with a few dark spots. The *Engystoma carolinense* ranges from South Carolina to western Texas, inclusive, and northwards in the Mississippi Valley to New Madrid, Mo. In Texas it is abundant in the north, at Dallas; then at Houston, San Antonio, and northwestward to Fort Concho. I heard it in the streets of Houston and San Antonio. In the former city it was abundant, in copulâ, in the ditches that border some of the streets, in September. The cry is loud for the size of the animal, and is similar to that of the *Bufo americanus*, except in being higher pitched and more nasal (in the vulgar sense). The animals are extremely shy, and become silent on the approach of human footsteps; and as only the tip of their nose projects above the water-level, they disappear beneath it without leaving a ripple.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3709	1	Washington County, Miss.		Col. B. L. C. Wailes	Alcoholic.
4744	1	Micanopy, Fla		Dr. T. H. Bean	Do.
4192	2	Riceborough, Ga		Dr. W. L. Jones	Do.
5910	4	do		Maj. J. Le Conte	Do.
3699	1	Columbus, Ga		Dr. Gesner	Do.
3707	1	do		do	Do.
3978	5	Calcasieu Pass, La		George Wurdemann	Do.
2973	1	Charleston, S. C		Dr. C. Girard	Do.
9396	1	Florida			Do.
9954	3	Little Sarasota Bay, Fla	1875	Prof. F. B. Meek	Do.
3705	1	New Madrid, Mo		R. Kennicott	Do.

PHRYNISCIDÆ.

Cope, Journ. Ac., Phila., 1867, p. 190.

I. Terminal phalanges enlarged at extremity:
Pupil horizontal; tympanum distinct; toes free..*Sphenophryne* Ptrs. & Dor.
Pupil horizontal; no membranum tympani; toes slightly webbed
.....*Scaphiophryne* Boul.

II. Terminal phalanges simple:
A. Pupil erect.
No tympanic disk; toes webbed.....*Melanobatrachus* Bedd.
A. tympanic disk; prefrontals joining each other and the frontoparietals
.....*Hypopachus* Keferst.

AA. Pupil round.
A. tympanic disk; prefrontals continuous; sclerotica ossified
.....*Stereocyclops* Cope.

AAA. Pupil horizontal.

I. Prefrontals fully developed, forming suture with each other and frontoparietals.
Ear perfectly developed; toes webbed; dorsum covered with a stratum of glands.....*Calophrynus* Tschudi.

II. Prefrontals small, widely removed from each other and from the frontoparietals:
A. Ear perfectly developed.
Two sharp-edged tubercles on metatarsus; toes little webbed; outer toe rudimental; muzzle simple.....*Copea* Steind.*
No tubercles on metatarsus; toes slightly webbed, outer rudimental; muzzle simple; two lobes of the liver.....*Atelopus* D. & B.
Tubercles of tarsus rudimental; toes slightly webbed, all well developed; a horizontal dermal process on extremity of muzzle..*Rhinoderma* D. & B.

AA. Ear imperfectly developed.
Toes slightly webbed, outer small; metatarsus simple; muzzle simple; liver with two lobes.....*Phrynidium* Martens.
Toes slightly webbed, no cutting metatarsal tubercles or dorsal dermal shield; three lobes of the liver.....*Phryniscus* Wiegm.
Toes slightly webbed; no cutting tubercles; a dorsal osseous dermal shield, confluent with vertebral apophyses.....*Brachycephalus* Fitz.

One species of this family has been observed in North America. The distribution of the known species is as follows: Sphenophryne, 1 species, New Guinea; Scaphiophryne, 2 species, Madagascar; Melanobatrachus, 1 species, India; Hypopachus, 3 species, Mexico and Central America; Stereocyclops, 1 species, Brazil; Calophrynus, 2 species Borneo, 1 species, Madagascar; Copea, 1 species, Brazil; Atelopus, 1 species, Central America; Phrynidium, 11 species, South America; Rhinoderma, 1 species, Chili; Phryniscus, 1 species, South America; Brachycephalus, 1 species, Brazil; total, 27.

HYPOPACHUS Keferstein.

Göttingen Nachrichten, 1867, p. 352; Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882, p. 159.

No frontoparietal fontanelle. Frontoparietal and prefrontal bone in contact, concealing the ethmoid. No omosternum. No dermo-ossi-

* The sternum of this genus not having been examined, its position is doubtful.

fications. Terminal phalanges simple. No vomerine teeth. Tongue simple, oval.

Three species of this genus are known, the rare *H. oxyrhinus* and the *H. variolosus*, which, with its subspecies Inguinalis Cope, ranges from Costa Rica to Guatemala on the east, and Michoacan on the west. A new one is now added. The species differ as follows:

Head one-sixth total length; toes with a short web; no lateral band. ..... *H. variolosus* Cope.

Head one-eighth total length; toes without trace of web; heel to humerus; no lateral band ..... *H. cuneus* Cope.

"Toes with a slight web; heel to end of muzzle; a blackish lateral band;" Boulenger ..... *H. oxyrhinus* Boul.

HYPOPACHUS CUNEUS Cope.

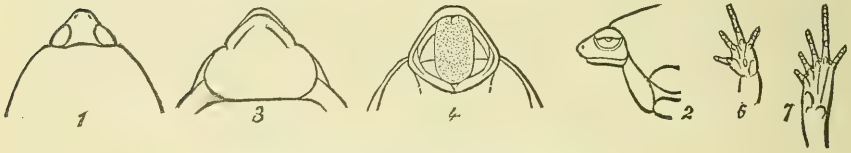


FIG. 98. *Hypopachus cuneus.* San Diego, Tex.; ½.

Head small; body large; limbs short. Muzzle scarcely longer than diameter of eye, projecting a little beyond mouth border. A dermal groove across head at posterior borders of eyelids, and one from below posterior canthus of eye to shoulder. Another across thorax from the inferior origin of one humerus to the other. Skin everywhere smooth. Tympanic drum invisible. When the anterior limb is extended the end of the fore-arm reaches the end of the muzzle. The distal end of the tarsus reaches the anterior base of the humerus, and the end of the second toe reaches the end of the muzzle when the hind limb is extended. The third finger is rather elongate, and the lengths of the fingers are in order, beginning with the shortest, 1–2–4–3, the second and fourth being equal. In the posterior foot the lengths are, beginning with the shortest, 1–2–5–3–4, the second and fifth being about equal, and the third a good deal shorter than the fourth. The palmar tubercles are not very distinct. At the distal end of the tarsus there are two large, subequal, sharp-edged tuberosities. The edge of the internal is oblique, that of the external transverse. Distinct small tubercles under the articulation of the phalanges. The femur is almost entirely inclosed in the integument of the body.

The tongue is large, and forms an elongate flat ellipse. The internal nostrils are anterior, and are a little further apart than the external nostrils. The latter are nearly terminal in position.

The color is light brown, or grayish-brown, sometimes tinged with olive, and there is generally a pale median vertebral line. There is a wide band on each side of a paler tint, extending from the orbit to near

the groin. It is sometimes only indicated by a line of black specks, forming a border above and below. A pale line from eye to front of humerus. Numerous rather large black spots on the groin and numerous smaller ones on the posterior face of the femur, between which the color is often dark red. Small black spots on posterior faces of tibia and astragalus, anterior edge of tibia, and posterior edge of humerus. Digits with a light spot at each phalangeal articulation. Belly yellowish, with or without a faint coarse reticulation of a darker color.

Measurements.

	M.
Length of head and body	.041
Length of head to rictus oris	.006
Length to axilla, axially	.015
Length of fore limb on front	.022
Length of fore foot	.0095
Length of hind limb from anus	.046
Length of hind foot	.023
Width of head at rictus oris	.010
Width of extended femora	.031

As compared with the *H. oxyrhinus* of Boulenger (Ann. Mag. Nat. Hist., 1883, p. 344), this frog has much shorter hind legs and a different coloration, as well as some web between the toes, judging from Dr. Boulenger's description. The *H. oxyrhinus* comes from western Mexico. The *H. variolosus* is common in Central America and southern Mexico.

This species has been found thus far only in the neighborhood of San Diego, in Nueces County, in southwestern Texas. A number of specimens have been brought from that locality and been obtained for the United States National Museum, by William Taylor.

DENDROBATIDÆ.*

Cope, Nat. Hist. Rev., 1865, and Journ. Ac. Phila., 1867.

Hylaplesiidæ Günth., Cat. Batr. Sal. Brit. Mus., 1856; Mivart, Proceed. Zool. Soc. Lond.

There are but two genera of this family and they agree in the following characters:

O. o. prefrontalia widely separated; ethmoid broad, ossified to extremity of muzzle; no parotoid glands or metatarsal shovel; terminal phalanges with two divaricate limbs supporting dilations; tongue narrow, free, and entire behind.

They differ as follows:

"Omosternum and sternum with bony styles" ..... *Mantella* Boul.
Omosternum weak, semiossified; sternum cartilaginous ..... *Dendrobates* Wagl.

The species of these genera are distributed as follows: Mantella, 4 species, Madagascar; Dendrobates, 8 species, Central American, Colombian, and Brazilian regions of Neotropical realm.

* Plate 74.

COPHYLIDÆ.

But two genera are known, as follows:

Tips of fingers and toes dilated; sternum small ..... *Cophyla* Boettg.
Tips of fingers and toes acute; sternum large ..... *Phrynocara* Peters.

There is but one species of each of these genera and they inhabit Madagascar.

DYSCOPHIDÆ.

Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882, p. 179.

The genera of this family are as follows: The definitions are taken from Boulenger, *l. c.*, p. 473.

I. Pupil vertical.
  Vomerine teeth in long series; sternum very large; fingers and toes, tips not dilated ..... *Dyscophus* Grand.
  Vomerine teeth in long series; sternum small; fingers and toes, tips not dilated ..... *Calluella* Stoliczka.
  Vomerine teeth in long series; sternum small; fingers and toes, tips dilated ..... *Plethodontohyla* Blgr.
II. Pupil horizontal.
  Vomerine teeth in two small groups; sternum small; tips of fingers and toes dilated ..... *Platypelis** Blgr.

The species are distributed as follows: Dyscophus, two species, Madagascar; Calluella, one species, Farther India; Plethodontohyla, three species, Madagascar; Platypelis, two species, Madagascar.

COLOSTETHIDÆ.

Cope, Journ. Ac. Phila., 1867, 190–197.

But one genus of this family is known, which is defined as follows:

Cranium fully developed; ethmoid plate broadly ossified to end muzzle, separating the narrow prefrontals; terminal phalanges with transverse limb supporting digital dilatations; no vomerine teeth or metatarsal tubercles; tongue cylindric, free behind ..... *Colostethus* Cope.

The only known species of this genus, *Colostethus latinasus* Cope, belongs to the Columbian region of the Neotropical realm.

RANIDÆ.

Ranidæ, part., *Cystignathidæ*, part., *Polypedatidæ*, *Hylodidæ*, part., Günth., Cat. Batr. Sal.
Ranidæ Cope, Nat. Hist. Rev., 1865; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 3.
Polypedatidæ, part., and *Ranidæ*, part., Mivart, Proceed. Zool. Soc., 1869.

Upper jaw toothed; diapophyses of sacral vertebra not or but very slightly dilated.

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* *Mantipus* Peters, 1883, is the same.

The members of this family show no great difference in the structure of the sternal apparatus. The precoracoids are always present, their axis being parallel with that of the coracoids, and their distal extremity resting upon that of the latter. The precoracoids are much weaker than the coracoids. In most genera an omosternum and a sternum are well developed, and furnished with a bony style. In Oxyglossus, Hylixalus, and Prostherapis the sternum lacks the bony style, and so does also the omosternum in Nannophrys and Phyllodromus.

The vertebræ are procœlous. The urostyle is attached to two condyles. There are no ribs.

A frontoparietal fontanelle is constantly absent.

The distal phalanges may be simple, pointed, or subtriangular, T-shaped, Y-shaped, or even claw-shaped (Hylambates), the latter structure being met with elsewhere in the Hylidæ, Amphignathodontidæ, and Hemiphractidæ only.

Members of the Ranidæ existed during the Miocene period. The remains of *Rana meriani** indicate a species as large as *R. esculenta*. *Rana noeggerathi*, also from the Braunkohle near Bonn, was a small species, of which I have not been able to learn the form of the sternum. If the species was not a Rana, it did not belong to any other existing genus of the family. The genus Asphærium† (found in the Oeningen bed) possessed a humerus without terminal condyle. This may be the result of accident to the skeleton.

The skeletal modifications in this family are those of the ethmoid and prefrontal bones and of the posterior extremity.

The genera of the Ranidæ are as follows:

I. External metatarsals bound together; omosternum and sternum both without osseous style.
  Pupil vertical; tongue emarginate; vomerine teeth; toes free ..... *Nannobatrachus* Blgr.
  Pupil horizontal; tongue emarginate; vomerine teeth; toes free ..... *Nannophrys* Gthr.

II. External metatarsi bound; omosternum with style; sternum without style.
  Pupil horizontal; tongue heart-shaped; no vomerine teeth; toes webbed, tips with disk ..... *Hylixalus* Esp.
  Pupil horizontal; tongue entire; no vomerine teeth; toes free; tips with disks ..... *Prostherapis* Cope.
  Like Prostherapis, but the tongue emarginate (Blgr.) ..... *Phyllobates*‡ Bibr.

III. External metatarsi bound together; omosternum without, sternum with, osseous style.
  Pupil horizontal; tongue entire; no vomerine teeth; toes free; tips with disks ..... *Phyllodromus* Esp.

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* Von Meyer, Palæontographica, III, p. 127.

† *A. reussii* Von Meyer, *l. c.*, II., p. 68.

‡ This genus, which I placed provisionally in the Cystignathidae, not having seen the sternum, belongs here according to Boulenger. The name must be, therefore, erased from the table on page 313.

IV. External metatarsi bound; omosternum and sternum with osseous style.

a. Terminal phalanges ball and claw; an intercalated penultimate phalange.

Pupil vertical; tongue emarginate; vomerine teeth; tips of digits dilated ..... *Hylambates* Dum.

aa. Terminal phalanges simple.

β. An intercalated penultimate phalange.

Pupil vertical; tongue heart-shaped; vomerine teeth; fingers and toes free or nearly so ..... *Cassina* Gird.

ββ. No intercalated phalange.

Pupil horizontal; tongue heart-shaped; vomerine teeth none; toes nearly free ..... *Arthroleptis* Smith.

aaa. Terminal phalanges bifurcate.

β. An intercalated penultimate phalange.

Pupil horizontal; tongue heart-shaped; no vomerine teeth; fingers and toes more or less webbed ..... *Hyperolius** Rapp.

Characters of Hyperolius, but pupil vertical ..... *Megalixalus* Gthr.

ββ. No intercalated phalange.

Pupil horizontal; tongue emarginate; vomerine teeth; fingers and toes free or nearly so ..... *Cornufer* Tsch.

V. External metatarsi separated by web; omosternum and sternum with osseous style.

α. No intercalated phalange.

Pupil vertical; tongue emarginate; vomerine teeth; toes webbed ..... *Nyctibatrachus* Blgr.

Pupil horizontal; tongue emarginate; no vomerine teeth; toes webbed ..... *Heteroglossa*† Hallow.

Pupil horizontal; tongue emarginate; vomerine teeth; fingers free; toes webbed; ethmoid bone osseous above ..... *Rana* Linn.

Pupil horizontal; tongue emarginate; vomerine teeth; fingers free; toes webbed; ethmoid bone cartilaginous above ..... *Ranula* Pet.

Pupil horizontal, tongue emarginate, no vomerine teeth; ends of digits enlarged ..... *Micrixalus* Blgr.

αα. An intercalated penultimate phalange.

Characters of Rana, but fingers more or less webbed; ends of digits enlarged ..... *Rhacophorus* Kuhl.

Characters of Rhacophorus, but two inner fingers opposite the two outer ..... *Chiromantis* Pet.

Pupil horizontal; tongue emarginate; no vomerine teeth; ends of digits enlarged ..... *Ixalus* D. & B.

Like Ixalus, but pupil vertical ..... *Nyctixalus* Blgr.

VI. External metatarsals separated by a web; sternum without long style; omosternum with one.

Pupil horizontal; tongue entire posteriorly; vomerine teeth none ..... *Oxyglossus* Tsch.

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* Rappia Gthr., but sufficiently distinct from *Hyperolia* Gray.

† *Phrynobatrachus* Günth.; *Stenorhynchus* Smith; *Leptoparius* Peters; ? *Staurois* Cope.

It will be readily seen by the following table that the geographical distribution of this family is almost entirely in the Old World:

	Realms.					
	Australian.	Neotropical.	Nearctic.	Ethiopian.	Palæarctic.	Palæotropical.
Nannobatrachus						1
Nannophrys						2
Hylixalus		2				
Prostherapis		4				
Phyllobates		5				
Phyllodromus		1				
Hylambates				11		
Cassina				2		
Arthroleptis				8		
Hyperolius				22		
Megalixalus				7		
Cornufer	2					7
Nyctibatrachus						2
Heteroglossa				3		
Rana	2		13	34	11	49
Ranula		4				
Rhacophorus				5		25
Micrixalus						5
Chiromantis				3		
Ixalus						20
Oxyglossus						3
Total	4	16	13	95	11	111

The only genus of the Nearctic fauna is, then, Rana.

RANA Linn.

Systema Naturæ x, p. 354, pars; Wagler Syst. Amph., 1830, p. 203; Günth., Cat. Batr. Sal., p. 8; Cope, Nat. Hist. Rev., 1855, p. 117.

Hylarana Tschudi, *l. c.*, p. 78; Günth., *l. c.*, p. 71; ; Cope, *l. c.*
Polypedates, sp., Tschudi, *l. c.*, p. 73; Günth., *l. c.*, p. 77.
Strongylopus Tschudi, *l. c.*, p. 79.
Pyxicephalus Tschudi, *l. c.*, p. 83; Cope, *l. c.*
Pyxicephalus, sp., Dum. & Bibr., *l. c.*, p. 442.
Linnodytes Dum & Bibr., *l. c.*, 510.
Pelophylax Fitzing. Syst., Rept., I., p. 31.
Tomopterma (Bibr.) Günth., *l. c.*, p. 7.
Sphærotheca Günth., *l. c.*, p. 20.
Dicroglossus Ethn. Proceed. Zool. Soc., 1860, p. 158.
Hoplobatrachus Peters Mon. Berl. Ac., 1863, p. 449; Cope, *l. c.*
Pachybatrachus (non Keferstein), Mivart, Proc. Zool. Soc., 1868, p. 559.
Clinotarsus Mivart, *ibid.*, 1869, p. 227.
Maltzania Bœttger, Abhandl. Senck. Ges., XII, 1881, p. 417.

Omosternum with osseous style; no frontoparietal fontanelle; ethmoid bone ossified above; vestibule of the ear functional; Eustachian tubes open; vomerine teeth present; tongue with two posterior cornua; fingers free; toes webbed; ossification of skull not penetrating the skin, which is therefore free.

This genus contains, according to the latest enumeration (that of Mr. Boulenger,) one hundred and eight species, which belong mostly to the Old World. The family of Ranidæ, indeed, is only represented in the Western Hemisphere by four other genera, of the Neotropical realm,

which includes but sixteen species. In the Old World the genus Rana occurs everywhere excepting in the Australian realm, with the exception of a single species in north Australia, and two in New Guinea. The *Rana papua* Less. is found in New Guinea and on the northern peninsula (Cape York) of Australia. Otherwise the batrachian fauna of Australia is arciferous. Its absence from South America is absolute, and the only genus which is nearly related to it, *Ranula* Pet., has but four species.

The relations of the prefrontal and ethmoid bones are very various in this genus, furnishing us with illustrations of most of the types found throughout the order, which are usually characteristic of higher groups. The names of the faunæ in the accompanying table refer to the species of Ranidæ as given in the second column.

A coincidence between the condition of these prefrontal bones and the regions inhabited by the species is evident, as well as a certain succession in the latter: Neotropical first, Palæotropical last.

Ranidæ, Group IV.		Geographical distribution.	Other groups.
A. Prefrontals lying along canthus rostralis, separated by ethmoid throughout.			
a. Ethmoid cartilaginous.	*Ranula*	Neotropical	
aa. Ethmoid projecting a short distance beyond frontoparietals.	*Rana oxyrhyncha*	South Ethiopian	
	R. mascariensis		
	Heteroglossa plicata	Palæotropical	
	S. g. Hylarana (young)	do	
	R. (H.) malabarica	do	
aaa. Ethmoid produced far between prefrontals.	*Rana fasciata*	South Ethiopian	*Engystomidæ*, Gr. II.
	S. g. Hylarana, in gen.	Palæotropical	*Hylidæ* (most).
	S. g. Amolops	do	*Cystignathidæ*, Gr. II.
			Dentrobatidæ.
			Ceratophrys.
			Xenophrys.
B. Prefrontals subtriangular, not united by suture medially, or in contact with frontoparietal.	*Rana temporaria*	Palæotropical and Nearctic.	
	R. esculenta	Palæarctic	
	R. virescens	Nearctic	*Cystignathus.*
	R. clamata	do	
	R. catesbiana	do	
	R. cyanophlyctis, jun.	Palæotropical Alpine.	
C. Prefontals more or less united by suture medially, not touching frontoparietals.	*Heteroglossa natalensis.*	South Ethiopian	*Scytopis.*
	Rana fuscigula	do	
D. Prefrontal united by suture, and more or less completely in contact with frontoparietals.	*Heteroglossa africana*		
	Rana occipitalis	Ethiopian	
	R. gracilis	do	*Engystomidæ*, Gr. I.
	R. tigrina	Palæotropical	*Bufonidæ.*
	R. cyanophlyctis	do	*Cystignathidæ*, Gr. I and IV.
	R. grunniens	do	
	R. hexadactyla	do	
	R. corrugata	do	
	R. ehrenbergii	do	
	Oxyglossus lima	do	

The North American Ranæ belong apparently to thirteen species. Three of these present us with six subspecies additional to their typical forms, whose distinctive characters approach those of species. Two of the species of the West Coast are not distinguishable, excepting as subspecies, from two of the Palæarctic realm, which range from Eu-

rope eastwards to the Sierra Nevada or to the Rocky Mountains. In this genus is repeated the phenomenon observable elsewhere, that the species of the Atlantic Coast region are more different from those of the Old World than are those of the Pacific coast.

The longitudinal dorsal ridges constitute a peculiar feature not found in any of the other genera of Batrachia Salientia of the United States. They exist in most of the species, with the exception of *R. catesbiana* and *R. montezumae*. Sometimes the skin above is perfectly smooth, sometimes roughened by tubercles; the same species will occasionally present both extremes under different circumstances. The vocal sacs—one on each side of the throat—are, when inflated, visible externally in *R. virescens*, *areolata*, and *montezumæ;* possibly in others. The amount of webbing between the toes varies from the fullest condition in *R. catesbiana*, *septentrionalis*, and *boylii*, to the half webbing of *R. areolata*.

The distinctive characters of the species are derived from the comparative bulk of the body or limbs; the presence or absence of dorsal ridges; the comparative length of fore-arm and hand; of femur, tibia, foot, and body; the amount of webbing between the toes; the comparative length of the third and fifth toes (the fourth being always longest); the shape of the tongue; the position of the vomerine teeth; the size of eye and tympanum, etc. The colors may present dark blotches, areolated or not, reticulations or marmorations on a light ground, or light sinuations or spots on a dark ground. Many species have a light line along the jaw, which begins distinctly either at the nostrils or under the eye. Those in which this line is wanting are *R. catesbiana*, *montezumæ*, *areolata*, *septentrionalis*, *boylii*, and some varieties of *clamata*. Specimens vary much, even of the same species, with latitude and external circumstances. As a general rule, those from the north are larger, darker, and more pustular, so much so, that for *R. catesbiana*, *palustris*, *virescens*, and *clamata* it is quite easy to establish two or three different races, some of them even raised to the rank of distinct species. As, however, all intermediate stages may be detected on a close examination of many specimens from the same locality, although a general adherence to the type is preserved, it becomes impossible to assent to the retention of several long-established species.

The following tabular analysis gives in a synoptical form the most salient features of the different species. It is, however, impossible here, as elsewhere, to indicate characters which shall apply with mathematical accuracy to all specimens of the same species. The dimensions, proportions, color, and other characters may vary to a considerable extent, and it is only by striking the balance of all the features of a species that we can determine its true position.

I. Heel of extended hind limb reaching to or beyond extremity of muzzle; vomerine teeth entirely between choanæ. (No black ear-patch.)
Dorsal dermal plicæ thin, usually more than two between the lateral ones; spots usually smaller, rounded; males with vocal sacs ..... *R. virescens.*

II. Heel of extended hind limb not reaching end of muzzle; vomerine teeth between, but projecting posterior to posterior border of choanæ. (No black ear-patch.)

α. Males with an external vocal vesicle.
A dorsolateral dermal fold, with others between; three phalanges of fourth toe free from web; legs cross-barred ..... *R. areolata.*
Dorsolateral fold only; two phalanges of fourth toe free from web; heel scarcely reaching tympanum, which is nearly as large as eye; brown, with small gray (or in life green) spots ..... *R. montezumæ.*

αα. No external vocal sacs in males.
Four dermal dorsal ridges; two phalanges of fourth toe free; colors pale, with rows of large quadrate brown spots ..... *R. palustris.*
Dermal fold, size of tympanum, and extent of web variable; length not exceeding 6 centimeters; large dark spots on back ..... *R. septentrionalis.*
A dorsolateral dermal fold; web leaving two phalanges of fourth toe free, no dorsal spots; size not exceeding 8 centimeters ..... *R. clamata;*
No dorsolateral dermal fold; web *generally* leaving one phalange of fourth digit free; length reaching 20 centimeters ..... *R. catesbiana.*

III. Heel not reaching end of muzzle; vomerine teeth behind choanæ. (A black ear-patch.)
Usually two phalanges of fourth digit free; internal cuneiform tubercle small ..... *R. temporaria.*
Usually three phalanges of fourth digit free; internal cuneiform tubercle large and prominent; middle of back rarely spotted; small, size 5 centimeters ..... *R. cantabrigensis.*

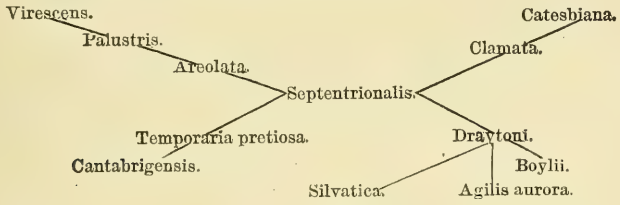
IV. Heel reaching or exceeding end of muzzle, vomerine teeth behind choanæ. (A black ear-patch.)

α. Tympanic disk distinct.
Head short, obtuse, entering length 3.5 times; third phalange of fourth toe bordered by web and last two free; cross-bands of tibia imperfect or very few, dorsal spots small (in American subspecies) ..... *R. agilis.*
Head obtuse, entering length about three times; palmation bordering penultimate phalange, leaving the last one free; dorsal spots large; size large, reaching 12 centimeters ..... *R. draytoni.*
Head acute, three times in length; back without large spots; web bordering antepenultimate phalange, leaving two free; small, length 5 centimeters ..... *R. silvatica.*

αα. Tympanic disk concealed.
Head obtuse; palmation extending to base of last phalange; skin thick, glandular; size small ..... *R. boylii.*

It may be seen from the above table that the species of Rana found in North America are closely related, and that their discrimination requires close attention. More or less numerous exceptions to the definitive characters above given exist, and increase the difficulty of distinguishing them. Thus the hind legs of the *Rana palustris* are of variable lengths, about half the specimens having them long, as in *R. virescens.* In the latter, the vomerine teeth in the subspecies Brachycephala frequently are placed a little posteriorly, as in the *R. palustris.* The latter again sometimes has four dorsal ridges, as in *R. virescens.* Sometimes

the vomerine teeth in *Rana temporaria pretiosa* are not appreciably more posterior in position than in *Rana septentrionalis*, in which case the species approach each other very closely. The *Rana septentrionalis* violates the characters which distinguish the *R. clamata* and *R. catesbiana* from each other, and would afford a complete connection between them were it not for its inferior size; but even this point does not invariably hold good, as a few specimens of *R. clamata* do not exceed it in dimensions. Three specimens have been found which relate very closely the *R. silvatica* and *R. cantabrigensis*, two of which are referred to the former and one to the latter species on other characters, which are not numerous. A subspecies latiremis of *R. cantabrigensis*, from Alaska, approaches the *R. temporaria* in its wide palmation; and there is a specimen (9420) which is quite intermediate between the *R. agilis* and the *R. draytoni*. The chain of affinities indicated by these intermediate specimens may be sketched as follows:



These series are not probably genetic, as some of the species have been most likely derived from the Old World. The *R. septentrionalis*, however, may be very probably ancestral to the forms of the Catesbiana series, and perhaps of others.

The species of Rana are well protected from enemies by an extremely acrid secretion of the skin. An animal of much superficial sensitiveness is not likely to take a frog into the mouth a second time. Domesticated dogs and cats avoid them, but snakes evidently have no such scruples against feeding on them.

RANA VIRESCENS Kalm.*

Resa til Norra America, III, 1861, p. 46; Schreber, der Naturforscher, XVIII, 1782, p. 185; Pl. IV. Garman, Bull. Essex Inst., XVI, p. 41.

Rena halecina "Kalm," Schreber, *l. c., nec. kalmii;* Daudin (Kalm), Hist. Nat., Reptil., VIII (1803), 122, 432; 1 b. Hist. Nat. Rain., etc. (1803), 63; Harlan, Sillim. Amer. Jour. Sci., X (1825), b. 1.; Journ. Ac. Nat. Sci. Phila., V (1827), 337; 1 b. Med. and Phys. Rept. (1835), 102–224; Storer. Rept. Mass. Reptil. (1839), 237; Holb., N. Amer. Herp., 1st ed., I (1836), 89, XIII; 1 b. 2d ed, IV (1842), 91, XCI; Dum. & Bibr., Erp. Gén., VIII (1841), 352; Thompson, Nat. Hist. Vt. (1842), 120; De Kay, N. Y. Zool., III (1842), XX, fig. 49; Hallow., Proceed. Ac. Phila. (1856), 141.

Rana aquatica (water frog), Catesby, Carol., II (1743), 70; Klein, Quadruped, p. 119.

Rana pipiens Gm., ed. L, Syst. Nat. (1788), 1052, 28; Bonnaterre, Encyclop. Meth. Erpet. (1789), 5, IX, fig. 2; Schneider, Hist. Amph. fasc. 1 (1799), 153; Shaw, Gen. Zool., III, Amph. (1802), 105.

Rana utricularia Harlan, Sillim. Journ., X (1825), 60; Journ. Ac. Nat. Sc., V (1827), 337; 1 b. Med. and Phys. Rept. (1835), 102, 223.

* Plates 50, figs. 1, 2; 51, figs. 1, 9.

Rana virginiana Lam., Syn. Rept., p. 31.
Rana palustris Guérin, Iconogr. Rept., Pl. 26, fig. 1.
Rana oxyrhynchus Hallow., Proceed. Ac. Phila. (1856), p. 142.
Rana berlandieri Baird, U. S. Mex. Bound. Surv., Rept., p. 27, Pl. 36, fig. 7–10.

Vomerine teeth in two scarcely oblique groups between the choanæ. Head moderate; snout rather pointed; interorbital space half as broad as the upper eyelid; tympanum distinct, nearly as large as the eye. Fingers moderate, first extending beyond second; toes not quite webbed to the end; subarticular tubercles of fingers and toes well developed; inner metatarsal tubercle very small, blunt; no outer one. The hind limb being carried forward along the body, the tibio-tarsal articulation reaches nearly the tip of the snout. A prominent, narrow, glandular lateral fold. Olive or grayish-brown, changing to green, above, with regular oval or rounded, medium-sized, dark brown, light-edged spots; legs cross-barred; beneath immaculate. Male with two generally well-developed vocal sacs. North and Central America.

There are four subspecies of the *Rana virescens*, which pass into each other by occasional intermediate specimens. They differ as follows:

Head entering length of head and body two and a half or less than three times; males with external vesicles; muzzle more acuminate; no cross-bars on tibia; spots smaller ..... *R. v. sphenocephala.*

Head entering length of head and body two and a half to nearly three times; no external vocal vesicles; muzzle more or less acuminate; spots less distinct; tibia generally cross-barred; no longitudinal band in front of femur ... *R. v. austricola.*

Head acuminate but shorter, entering the length three times; males with external vocal vesicles; spots smaller, not so distinctly yellow bordered; cross-bars of tibia generally interrupted; a longitudinal band on the front of the thigh. ..... *R. v. virescens.*

Head shorter and more obtuse, entering the length three and a half times; males without or with rudimental external vocal vesicles; dorsal spots larger, widely yellow bordered; tibial cross-bands complete; no longitudinal band on the front of the thigh ..... *R. v. brachycephala.*

The last-named subspecies is the one I called *R. v. berlanderi*, but it turns out that the typical specimens of that species belong to the subspecies Virescens. The latter is the *Rana utricularia* of Harlan, but it is also the true *R. virescens* of Kalm.

The characters which distinguish the above subspecies are not without exceptions. Some specimens (No. 13372) from Wheatland, Ind., are intermediate in the length of the head between the longer and shorter forms. Quite trustworthy is the non-barring of the tibia in separating the *R. v. sphenocephala*, but it is less constant in the *R. v. virescens*. Thus in the *R. v. virescens* two specimens (3431) from Saint Louis, Mo., and one (3429) from Grand Detour, Ill., have two complete tibial cross-bars, and No. 3303 has three; No. 10046 has only one. In the *R. v. brachycephala* there are two or three such bars, but in the following specimens there is but one complete, or all are interrupted: Nos. 4794, 3427, 3418, 9998, 8499, 11926. The spots are smaller, and like the

larger spotted Virescens in 8501, 3295, 9347, and 3326. In 4548, from Mexico, the nose is acute as in *R. v. virescens*.

This species has the widest range of any North American frog. It is found from the Atlantic coast to the Sierra Nevada Mountains, and from Athabasca Lake, in the north, to Guatemala inclusive to the south. It does not occur on the Pacific coast. The common Mexican form *R. v. austricola* Cope has been misnamed *R. lecontei* by most modern writers. The latter name belongs to the *R. draytoni*.

Mr. Garman has in the bulletin of the Essex Institute called attention to the fact that the name *R. halecina*, by which this species is generally known, which is supposed to have been given by Kalm, does not occur in the writings of that author, who really calls it *R. virescens*. In a letter to me he states the case as follows. He begins with a quotation from Kalm:

En Resa til Norra America, III, 1761, p. 46. Deras färg är smutsig grön, strödd hår och där med brunaktiga fläckar. * * *

De torde kunna kallas: Rana virescens plantis tetradactylis fissis, palmis pentadactylis semipalmatis, macula depressa fusca pone oculum.

The paragraph from which the above is quoted begins with "Sill-häppetåssor kallades här af de Svenska en art af grodor," etc. The name *Rana helecina* does not occur in the text. The first appearance of this name that occurs to me is in "Der Naturforscher," XVIII, 1782, p. 185.

Schreber here figures the species, on Plate IV, so well, there can be no mistake. He refers to the synonymy as follows:

Der Pipfrosch, *Rana pipiens*, S. Tab. iv. *Rana aquatica*. Catesb., *Carolin.*, 2, p. 70, *tab.* 70. KLEIN., *Quadrup.*, p. 119.

Rana virescens, plantis (muss heissen: palmis) tetradactylis fissis, palmis (muss heissen: plantis), pentadactylis semipalmatis; macula depressa fusca pone oculum. Kalm Resa til Norra America, *tom.* 3, *p.* 46.

Rana halecina, Sill-hoppetossor, Kalm, *l. c.*, p. 45.

Where Schreber gets his *Rana halecina* from Kalm, I do not know. It is not in the Resa of Halle, 1753–1761. We do not find it in the translation by Forster, 1772, in English. Possibly it may occur in the translation by Murray, Göttingen, 1754–'64, Beschreibung der Reise, etc., which is not at hand.

Rana virescens sphenocephala Cope.

Rana oxyrhyncha Hallow. Proceed. Ac. Phila. (1856), p. 142. Not of Sundevall.

The typical forms of this species come from Georgia and Florida. These look like a different species from that which is found throughout the interior of the continent, and represent the *R. oxyrhyncha* of Hallowell. I describe a specimen from the former State.

Viewed from above, the muzzle is elongate and acuminate, and the narrow apex is rounded and projects well beyond the lower jaw. The nostril is at a point half-way between it and the anterior border of the orbit. The canthus rostrales are well within the plane of the lips,

and are nearly parallel. The interorbital space is considerably narrower than the width of a superior eyelid. The tympanic disk is round and is a little larger than the eye. The vomerine teeth form transverse patches entirely between the choanæ; that is, their posterior edges do not reach the line connecting the posterior borders of the choanæ. The ostia pharyngea are considerably smaller than the choanæ.

The first is considerably longer than the second finger and equals the fourth. The heel reaches eight or ten millimeters beyond the end of the nose. The palmation is rather narrow and leaves three phalanges of the fourth toe free. The internal cuneiform tubercle is small, but is prominent, and has an acute edge. No external tubercle.

Between the dorsolateral dermal folds there are, on the dorsal region, four thin dorsal plicæ. On the pelvic region the external two are rudimental, while the middle pair are distinct, and near together or on each side of the urostyle.

In this specimen the dorsal spots are suboval, are rather large, and are not yellow bordered. The dorsolateral fold is yellowish-brown, and there is a series of brown spots of irregular size, but smaller than the dorsals, just exterior to it. Below these the sides become yellowish, like the belly, and have small brown spots. A dark-brown band extends from the nostril to the orbit, and is continued from the latter round the posterior border of the tympanic disk. A similar band extends from the infe-

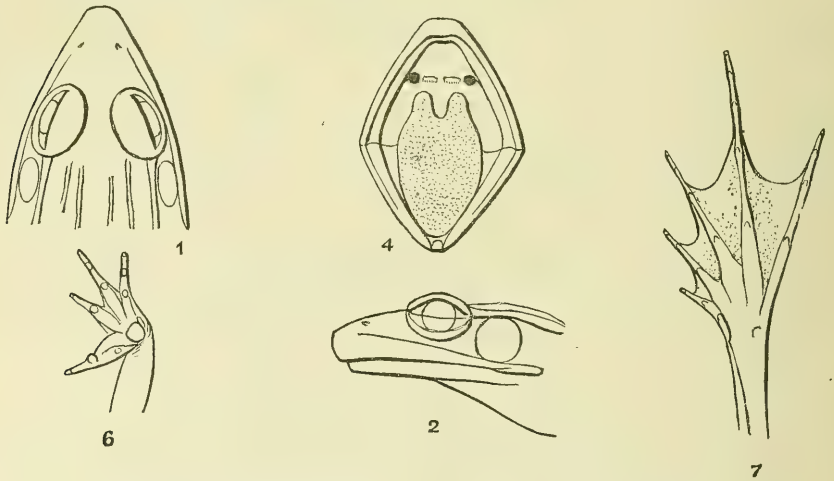


FIG. 99. *Rana virescens sphenocephala*. No. 11916. Nashville, Ga.; ½.

rior edge of the orbit to the lower edge of the ear-drum. The lips are brown, with small yellowish spots, and the superior brown is bounded above by a narrow yellow line, which commences below the front of the orbit and continues below the tympanic drum to above the posterior edge of the humerus. Below, everywhere light yellowish, unspotted. Posterior faces of femora brown, with paler coarse vermiculations. Femur with three brown spots above, and a longitudinal brown band

connecting the external with the groin anteriorly. This band is not present in all of the individuals of this form. Four brown spots on the anterior and on the posterior edges of the tibia, leaving the greater part of the upper surface uniform light brown. Two brown spots on the tarsus and two on the external metatarsus. A brown band on the humerus covering the elbow, one spot on the back and one on the front part of the forearm.

Measurements of No. 11916.

	M.
Length of head and body	.075
Width of head at posterior edges of tympana	.025
Length of head to posterior edges of tympana	.027
Length of fore limb	.036
Length of fore foot	.014
Length of hind limb to groin	.120
Length of tibia	.039
Length of tarsus	.022
Length of remainder of foot	.038

Rana virescens sphenocephala Cope.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
979	1	Fort Snelling, Minn		Dr. Geo. Suckley	Alcoholic.
11916	1	Nashville, Ga	1880	W. J. Taylor	Do.
3426	7	Prairie Mer Rouge, La		James Fairie	Do.
11477	1	Saint Simon's Island, Ga		J. P. Pastell	Do.
11950	1	Wheatland, Ind		Robt. Ridgway	Do.
3689	12	Liberty County, Ga		Dr. W. L. Jones	Do.
		New Orleans, La		Dr. R. W. Schufeldt	Do.
		Georgiana, Fla		W. Wittefelt	

Rana virescens virescens Kalm (Cope).

This subspecies differs from the *R. v. sphenocephala* in the relatively shorter head, being exactly intermediate between that form and the *R. v. brachycephala* in this respect. The hind legs are also a little shorter, the heel reaching exactly the end of the muzzle. The muzzle is also rather shorter, and the dimensions generally are rather smaller. The web is rather larger, as the antepenultimate phalange is widely margined, so that two phalanges only can be said to be entirely free. The spots are rather smaller, and separated by wider intervals.

In the coloration may be noted as characteristic the presence of a longitudinal brown band on the front of the thigh, in front of the spots. This is rarely absent. Less constant is the presence of a brown longitudinal stripe on the external edge of the tibia. Then there is always present a longitudinal brown band on the front of the humerus, commencing proximally and varying in length.

Dr. Holbrook describes the colors in life as follows:

Body green above, with ovate spots of dark brown margined with yellow; yellowish-white beneath.

This is one of our most beautiful species. There is an ovate black spot on the top of each orbit; a very bright bronze line* begins at the nose and runs to the eye; a second line of yellowish-white extends from the nose to the shoulder; the latter is less extensive in the male animal, ending at the vocal sac. The upper jaw is dark colored, with several yellowish-white spots; the lower jaw is almost white. The eyes are large and prominent; the pupil is black; the iris of a brilliant golden color, with a longitudinal black band passing through it. The tympanum is finely bronzed, with a yellowish spot on its center. The superior surface of the body is bright yellowish-green, marked with ovate spots of dark olive margined with bright yellow; these spots are disposed in two rows on the back, and in two others less distinct and less extensive on the sides. From the posterior part of each orbit runs an elevated line or cutaneous fold of a bright yellow, terminating near the posterior extremity of the body. The inferior surface is silver-white at the throat and yellowish-white on the abdomen. The anterior extremities are bronze green above, marked with several blotches of dark olive, one of which is very regularly found at the elbow; their inferior surface is whitish. The posterior extremities are bright green above, marked with dark olive oblong blotches and transverse bars; the inferior surface is pale flesh color and quite smooth, except at the posterior part of the thigh, where it is granulated.

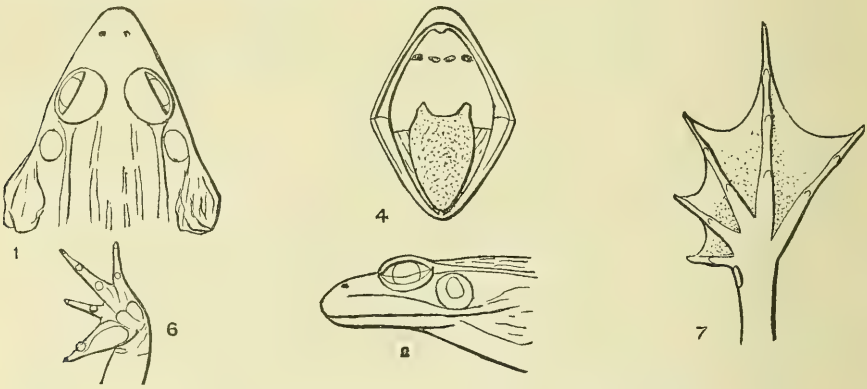


FIG. 100. *Rana virescens virescens.* No. 8869. Tickfau, Georgia; ½.

This species is especially an inhabitant of swamps. It is found in great numbers in those that border the large creeks and rivers of the Atlantic coast, and is comparatively rare inland, where it gives place to other species. With the *Acris gryllus*, it is the first species heard in spring, and although its voice is not loud, the noise produced by thousands of them is deafening when heard close at hand, and is transmitted through the atmosphere for many miles. It may be imitated by the syllables "chock, chock, chock." As a harbinger of spring it is always welcome.

* This line is yellowish in the young.

This species is found along the eastern and southern coasts from Maine to the mouth of the Rio Grande, and up the Mississippi to southern Illinois, and in the intermediate country. On the plains and westward and southward it is replaced by the following subspecies.

The *Rana virescens virescens* is the *R. utricularia* of Harlan.

Rana virescens virescens Kalm.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4698	3	Washington, D. C		John Little	Alcoholic.
3414	2	Riceborough, Ga		Prof. S. F. Baird	Do.
3428	8	Pensacola, Fla		Dr. J. F. Hammond, U. S. A.	Do.
8079	7	Southern Illinois		R. Kennicott	Do.
3323	2	Fort Smith, Ark		Dr. B. F. Shumard	Do.
3430	1	Russellville, Ky		Dr. Bibb	Do.
3419	7	Carlisle, Pa		Prof. S. F. Baird	Do.
3431	10	Saint Louis, Mo		Dr. G. Engelmann	Do.
3425	3	Charleston, S. C		Dr. C. Girard	Do.
8497	5	Taos, N. Mex		Dr. H. C. Yarrow	Do.
9343	2	Athabasca River, British America.		R. Kennicott	Do.
3436	1	Tarborough, N. C		J. L. Bridger	Do.
8239	1	Cairo, Ill			Do.
4830	1	Brookville, Pa		Dr. R. Haymond	Do.
8869	1	Tickfaw, La	Dec. 22, 1876	Bean and Maxson	Do.
3429	2	Grand Detour, Ill		Dr. P. R. Hoy	Do.
9342	2	Grand Coteau, La		St. Charles Coll	Do.
3450	3	Southern Illinois		R. Kennicott	Do.
3442	2	Saint Augustine, Fla		E. K. Smith	Do.
4871	3	Mexico		Lieut. B. Couch, U. S. A	Do.
9257	2	Washington, D. C	1877	Dr. T. H. Bean	Do.
9673	2	Cairo, Ill		R. Kennicott	Do.
2560	1	Southern Illinois		do	Do.
3403	1	Madrid, N. Y		P. R. Hoy	Do.
13593	1	(?)		(?)	Do.
13372	2	Wheatland, Ind		Robt. Ridgway	Do.
14552	1	Dallas, Tex		E. D. Cope	Do.
3282	10	Matamoros, Mexico		Lieut. B. Couch	Do.
11480	1	(?)		(?)	Do.
10046	2	Mount Carmel, Ill		Robt. Ridgway	Do.
10047	1	do		do	Do.
11525	4	New Madrid, Mo		(?)	Do.
11907	2	Nashville, Ga	1880	W. J. Taylor	Do.
11967	2	U. S. Arsenal, Washington, D. C.	1879	Dr. T. H. Bean	Do.
3692	3	Indian River, Fla		G. Wurdemann	Do.

Rana virescens brachycephala Cope.

Rana halecina berlandieri Cope, Check List, Batr., Reptil. N. Amer., p. 32; *nec Rana berlandieri*, Baird.

Rana halecina Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, p. 41; Brocchi, Mision Sci. de Mexique Batraciens, p. 10.

This is the most widely-distributed form of the *Rana virescens*, as may be seen by the accompanying list of specimens. It differs from the *R. v. virescens* by appreciable characters, but these occasionally present such exceptions, that I am unable to separate them as a species, as has been done by Mr. Boulenger. The characters already ascribed to the species belong to this form, but the further differences are as follows:

I select as typical a specimen from the Yellowstone River (No. 3363). The muzzle is less elongate, and the extended hind leg brings the heel

to its apex, but not beyond. The tympanic disk is two-thirds the diameter of the eye. The head is shorter, entering the length of the head and body three and a half times. The dorsal dermal plicæ are thicker and there are but two between the dorsolaterals; usually, however, there are four, as in the other sub-species. First finger longer than second. Web leaving two free phalanges of the fourth digit, but so repand as to give the antepenultimate phalange only a wide border. The inner cuneiform tubercle is rather small, but has a rather prominent compressed edge. External tubercle, none. A thick tarsal fold. There are no large warts on the skin, but there are occasionally minute warts and folds on the superior face of the tibia.

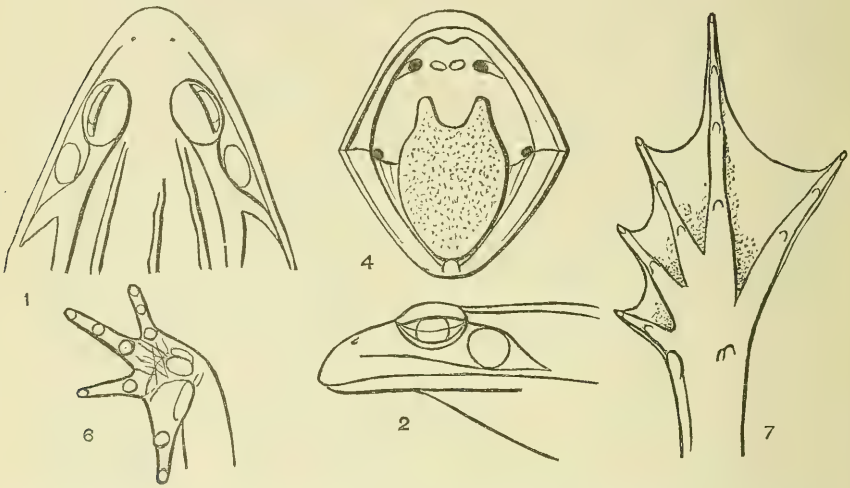


FIG. 101. *Rana virescens brachycephala*, No. 10922. Fort Walla Walla, Wash. Ter.; ½.

In life the color of the superior surfaces is green. The dorsolateral ridges are light yellow, and so is a stripe from the end of the muzzle, which passes above the lip and below the eye and tympanum to above the middle of the humerus. There are two rows of large, rounded dorsal spots between the dorsolateral ridges, which are edged with greenish-yellow. There are two similar rows on each side, of which the inferior is the smaller, which are not regularly arranged. There is a spot on each eyelid and one on the end of the nose above. There is a light band, frequently broken into spots near the edge of the upper lip. There is a brown spot on the elbow and one on the front of the cubitus. The bands seen on the front of humerus in *R. v. virescens* is here an illy defined spot. On the superior face of the femur there are three brown spots, but there is no longitudinal brown band in front of these spots, as is usual in the two other subspecies of the *R. virescens*. There are three complete wide brown cross-bands on the femur, and sometimes four. Frequently there are one or two spots on one or both faces of the tibia besides the three bands. The posterior face of the femur is greenish-yellow, coarsely marbled with brown. All the spots and bands are narrowly yellow-edged. Inferior surfaces light yellow, unspotted.

Measurements of No. 3363.

	M.
Length of head and body	.090
Width of head at posterior edges of tympana	.029
Length of head to posterior edges of tympana	.023
Length of fore leg	.043
Length of fore foot	.019
Length of hind leg to groin	.153
Length of tibia	.028
Length of tarsus	.024
Length of remainder of foot	.044

This is the common and only species of Rana found between the eastern part of the Great Plains and the Sierra Nevada Mountains. It is common wherever there is sufficient water to supply its necessities. In some of the Western towns it is eaten in the restaurants, and I have not unfrequently found it excellent food when the larder of my expeditions in search of fossils has run low.

Rana virescens brachycephala Cope.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3294	1	Albuquerque, N. Mex		Dr. C. B. R. Kennerly	Alcoholic.
3293	7	Brownsville, Tex		Capt. S. Van Vliet, U. S. A	Do.
3305	3	Leon River, Tex		Dr. C. B. R. Kennerly	Do.
3296	6	do		do	Do.
3300	1	San Antonio, Tex			Do.
3295	3	Chacho Escondido		Lieut. B. Couch, U. S. A	Do.
3302	1	San Pedro, Gila River, N. Mex.		J. H. Clark	Do.
8501	2	San Juan River, N. Mex		Lieut. R. Birnie, U. S. A	Do.
8498	1	Taos, N. Mex		W. H. Shedd	Do.
8499	1	Abiquiu, N. Mex		Dr. O. Loew	Do.
8500	1	Santa Fé, N. Mex	Sept. —, 1874	do	Do.
5456	1	Fort Bridger, Wyo			Do.
3375	1	Fort Dallas, Tex		Dr. Geo. Suckley, U. S. A	Do.
5273	1	Fort Buchanan, Ariz		Dr. B. J. D. Irwin, U. S. A	Do.
3356	1	Platte River, Nebr		W. S. Wood	Do.
3288	2	Red Bank Creek		H. B. Mollhausen	Do.
3342	5	Laramie River		W. S. Wood	Do.
9349	2	Fort Union, N. Mex		H. B. Mollhausen	Do.
3380	1	Between Fort Benton and Fort Union, N. Mex.			Do.
9347	1	Colorado River		H. B. Mollhausen	Do.
9346	1	Sand Hills, Nev		Dr. F. V. Hayden	Do.
3364	1	Medicine Bow Creek		W. S. Wood	Do.
3363	5	Yellowstone River		Dr. F. V. Hayden	Do.
3350	1	do		do	Do.
9339	1	South Fork		do	Do.
3341	1	Salt Lake Valley, Utah		J. S. Browne	Do.
3351	1	Fort Pierre, Nebr		T. Culbertson	Do.
3353	3	240 miles from Fort Kearny.		W. S. Wood	Do.
3439	4	Dunleith, Ill		Dr. C. B. R. Kennerly	Do.
4548	1	Valley of Mexico		J. Potts	Do.
3290	1	Headwaters of Trinity		Capt. John Pope, U. S. A.	Do.
3365	1	Chihuahua, Mexico		Dr. C. B. R. Kennerly	Do.
3348	11	Pole Creek of Platte		W. S Wood	Do.
8654	1	Utah	1872	Dr. H. C. Yarrow	Do.
9944	1	Fort Garland, Colo		H. W. Henshaw	Do.
9344	3	Taos, N. Mex	Aug. —, 1874	Dr. H. C. Yarrow	Do.
8101	2	Utah	1872	do	Do.
3413	1	Port Huron, Mich		do	Do.
3416	5	Quebec, Canada		do	Do.
3421	6	Racine, Wis		do	Do.
3427	3	Root River, Wis		do	Do.
4528	6	Red River of North		R. Kennicott	Do.
8090	10	Provo, Utah	1872	Dr. H. C. Yarrow	Do.

Rana virescens brachycephala Cope—Continued.

Catalogue number.	No of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4794	2	Nebraska		Dr. Geo. Suckley, U. S. A	Alcoholic.
3325	4	Fort Pierre, Nebr		Dr. Evans	Do.
9672	1	Camp Crittenden, Ariz	Aug. —, 1874	J. H. Rutter	Do.
9382	1	Lake Superior		R. Kennicott	Do.
14500	4	(?)		(?)	Do.
14501	1	Bedford, Iowa		Jordan & Meek	Do.
3349	8	Upper Mississippi and Yellowstone.		Dr. F. V. Hayden	Do.
9753	1	Webster City, Iowa	May —, 1878	Chas. Aldrich	Do.
3326	1	Fort Ripley, Minn		Dr. J. Head, U. S. A	Do.
8373	5	Sebec Pond, Me	Oct. 24, 1873	H. A. Leonard	Do.
9339	1	South Fork		Dr. F. V. Hayden	Do.
8378	5	Sebec Pond, Me		H. A. Leonard	Do.
9343	2	Abiquiu, N. Mex		Dr. O. Loew	Do.
3418	2	Columbus, S. C		Prof. L. Lesquereux	Do.
9998	1	Middletown, Conn		F. D. Shul	Do.
12585	4	John Day River, Oregon		Capt. Chas. Bendire, U. S. A.	Do.
11926	2	N. Boundary Survey		Dr. E. Coues, U. S. A	Do.
14173	1	Olney, Ill	1885	John and Chas. Walker	Do.
3422	6	Framingham, Mass		Prof. S. F. Baird	Do.
9738	1	Webster City, Iowa	1878	Chas. Aldrich	Do.
9346	1	Sand Hills, Nebr		Dr. F. V. Hayden	Do.
3320	2	Fort Union, Dak		E. J. Denig	Do.
5061	1	South Pass		C. McCarthy	Do.
3361	3	Pole Creek, Nebr		W. S. Wood	Do.
3368	1	Platte River		do	Do.
9459	2	Head of Yellowstone		Lieut. F. V. Hayden	Do.
11490	7	N. W. Boundary		Dr. E. Coues	Do.

RANA PALUSTRIS Le Conte.*

Rana palustris Le Conte, Ann. Lyc. N. Y. I, p. 282; Harlan, Sillim. Journ., X, p. 59, and Journ., Ac. Phila., V, p. 339; Dum. & Bibr., p. 356; Holbr., N. Amer. Herp., IV. p. 95, Pl. 23; De Kay, N. Y. Faun., Reptil. p. 62, Pl. 62. fig. 6; Le Conte, Proceed. Ac. Phila., 1855, p. 424; Weid., Nova Acta Ac. Leop., XXXII, p. 111; Günth., Cat., p. 14.

Rana pardalis Harlan, Amer. Journ., X p. 50.

This species approaches near to the subspecies *brachycephala* of the *Rana virescens*, although the distinction from the typical subspecies can be readily perceived. In general it displays little variation of characters, excepting in the length of the hind legs. Here about half the specimens show a length which allows the heel to reach the end of the muzzle, while in the other half it attains to different points from the front of the orbit anteriorly (*e. g.* No. 3401).

The muzzle is always more obtuse than in the *R. virescens virescens*, and generally a little more so than in the *R. v. brachycephala*, but not always. I describe a specimen from Garrison's, New York, as typical. Muzzle flat above; rather truncate in profile, giving the head, when viewed from above, a broadly obtuse acuminate outline. The nostril is a little nearer the end of the muzzle than to the orbit. The tympanic disk is two-thirds the diameter of the eye-fissure. The vomerine teeth are in transverse patches between the nares, but the posterior edge line projects behind that which connects the posterior edges of the choanæ. The ostia pharyngea are larger than the choanæ. There are no external

* Plate 57, fig. 3.

vocal vesicles. A glandular ridge extends from the middle of the inferior edge of the tympanic drum to a point above the middle of the humerus. There are four thick glandular folds on the back, the external or dorsolateral commencing above the tympanum. The thickness of these ridges is much greater than in the *R. virescens virescens*, but in some specimens of the *R. v. brachycephala* they approach very closely in form, and are in fact not distinguishable from those of individuals of this species where the ridges are narrower than usual. In a few individuals, of which the specimen described is one, there is another pair of ridges near the middle line of the back. In all the specimens these a represented in the pelvic region by a pair of approximated ridges on each side of the urostyle.

The interorbital width is two-thirds the width of an eyelid.

The tubercles of the palm are well developed. The first (second) finger is longer than the second, and equal to the fourth. The internal cuneiform tubercle is small and weak, and is without acute edge. There is a trace of an external tubercle. The toes are not fully webbed; the edges of the web are deeply scalloped, leaving two phalanges of the fourth toe free, and leaving only a narrow border to the distal half of the antepenultimate phalange.

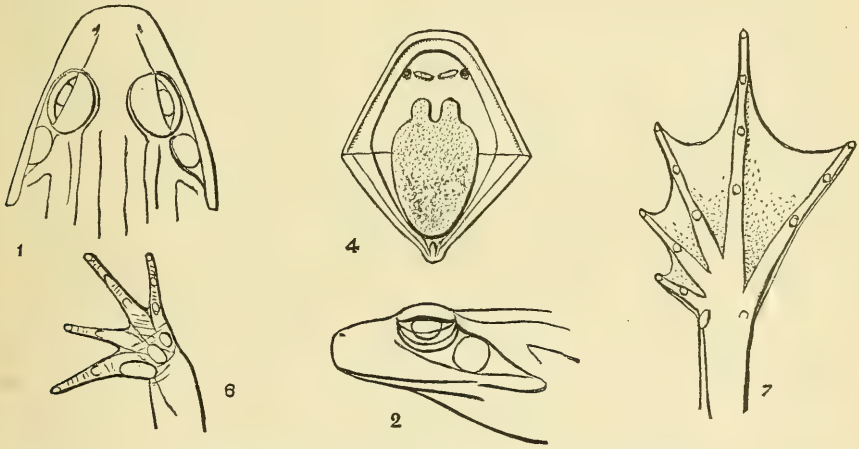


FIG. 102. *Rana palustris*. No. 13403. Garrison's, N. Y.; ½.

Measurements of No. 13403.

	M.
Length of head and body	.070
Width of head at posterior edges of tympana	.027
Length of head to posterior edges of tympana	.023
Length of fore limb	.037
Length of fore foot	.016
Length of hind leg to groin	.115
Length of tibia	.049
Length of tarsus	.020
Length of remainder of foot	.039

Dr. Holbrook thus describes the colors in life:

Body pale brown above, with two longitudinal rows of square spots of a dark brown color on the back and on each flank; yellowish-white beneath; posterior half of the thighs bright yellow, mottled with black.

The head has a dark brown spot on the top of each orbit and another near the snout, with an indistinct dark line extending from the nostrils to the orbit of the eye. The upper jaw is yellowish-white, spotted with black; the lower is white, and spotted in like manner. The eyes are large and prominent, the pupil black, with the iris of a golden color; the tympanum is bronze, with a spot of a darker shade in the middle. A yellow line begins at the eye and runs below the tympanum to the base of the anterior extremities. The superior surface of the body is pale brown, almost covered by oblong square spots of very dark brown, arranged symmetrically in two lines along the back. We sometimes find two of these squares confluent. A bright-yellow longitudinal line, but not raised in a cutaneous fold, as in *Rana virescens* begins behind each orbit and extends to the posterior extremity of the body. Below this line, on each flank, are two other rows of square brown spots, the superior row beginning on a level with and behind the tympanum, the inferior row is less regular, frequently consisting only of small spots, disposed without order. The inferior surface of the neck and abdomen is yellowish-white, except at the posterior part, where the yellow is more decided. The anterior extremities are yellowish-brown above, marked with a few very dark blotches; their lower surface is silver-white; the fingers are four in number, free, of a light brown color on the upper and yellow on the lower surface. The posterior extremities are brownish above, with transverse bands of dark brown continued to the toes. The inferior and posterior parts of the thigh are granulated, and of a bright yellow, with black spots. The inferior surface of the leg and tarsus is yellow.

This species is characteristic of the eastern district of North America, as it ceases to be found so soon as the Central Plains are reached. It ranges this entire district, extending as far north as Hudson's Bay.

In its habits it is not gregarious like the *R. virescens virescens*, and is even more solitary than the *R. v. brachycephala*. It prefers cold springs and streamlets, but is of all our frogs the most frequently seen in the grass. It is the most abundant species in the Alleghany Mountains. Next to the *R. silvatica*, it takes the longest leaps of any of our species. Its note is a low prolonged croak, somewhat resembling the sound produced by tearing some coarse material.

Rana palustris Le Conte.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3405	9	Carlisle, Pa		Prof. S. F. Baird	Alcoholic.
3412	10	do		do	Do.
3410	1	Meadville, Pa		do	Do.
3411	2	Philadelphia, Pa		J. H. Richard	Do.
3408	1	Framingham, Mass		Prof. S. F. Baird	Do.
3407	1	Washington County, Miss.		Col. B. L. C. Wailes	Do.
3400	1	Westport, N. Y		Prof. S. F. Baird	Do.
8345	1	Kinston, N. C		J. W. Milner	Do.
2402	4	Saint Louis, Mo		Dr. Geo. Engelmann	Do.
3409	3	Root River, Wis	July —, 1853	Prof. S. F. Baird	Do.
3406	1	Detroit River, Mich	Aug. —, 1853	do	Do.
3401	3	Prairie Mer Rouge, La		Jas. Fairie	Do.
9340	6	Pearl River, Miss		Miss Helen Tunnison	Do.
8905	1	Bainbridge, Pa	Apr. 12, 1877	Dr. T. H. Bean	Do.
5453	1	Toledo, Ohio		J. B. Trembly	Do.
3460	1	Tyree Springs, Tenn		Prof. R. Owen	Do.
3434	1	West Philadelphia, Pa		W. S. Wood	Do.
9388	3	Upper Wisconsin River		R. Kennicott	Do.
3417	1	Preston County, Va		Prof. E. B. Andrews	Do.
5921	3	James Bay, N. B		C. Drexler	Do.
9492	1	(?)		(?)	Do.
3328	1	Quasqueton, Iowa		E. C Bidwell	Do.
13403	1	Garrison's, N. Y		T. Rooseveldt	Do.
11499	1	(?)		(?)	Do.

RANA AREOLATA Bd. & Gird.

Proceed. Ac. Phila., 1852, p. 173; Baird, U. S. Mex. Bound. Surv., Reptiles, p. 28, Pl. 36, figs. 11–12; Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 41.

Head large; vomerine teeth opposite posterior edge of choanæ; tympanic disk two-thirds the diameter of eye or less. A strong glandular dorsolateral dermal fold on each side, and numerous shorter ones on the back between them. First finger longer than second. Three phalanges of front toe free. Males with an external vocal vesicle. Heel of extended hind leg reaching only to eye. Palmation short. Ground-color light, with numerous rounded spots on the back and sides. Upper lips spotted, not light or dark bordered above or on the margin. Hinder legs with numerous brown cross-bars. Lower surfaces unspotted.

This well-marked species is related to the *R. palustris*, but is easily distinguished. It presents three well-marked subspecies, whose characters I now give:

Length of head to posterior edge of tympana three times in total; tympanic disk round; dorsal spots well separated; nostril equidistant between end of muzzle and eye ..... *R. v. areolata.*

Length of head two and a half times in the total; tympanic disk a vertical oval; dorsal spots well separated; nostril equidistant between end of muzzle and eye ..... *R. v. æsopus.*

Length of head one-third of total; tympanic disk variable; dorsal spots so large as to leave only circles of the light ground-color; nostril nearer eye than end of muzzle in the young ..... *R. v. circulosa.*

But few specimens of these subspecies have been as yet found, but the characters presented in the above table will appear of importance

to those familiar with the subject. It is not impossible that one or the other of the subspecies may come to be recognized as species, but I scarcely anticipate that such will be the case. As a whole, the *Rana areolata* is pretty well distinguished by its very short palmation. Nevertheless, I have seen a specimen from Guatemala with similar posterior feet, which is otherwise not different from the *R. virescens*.

Rana areolata areolata Bd. & Gird.

Rana areolata Baird & Girard, Proceed. Ac. Phila., 1852, p. 173; Baird, U. S. Mex. Bound. Surv., Pl, 36, figs. 11, 12.

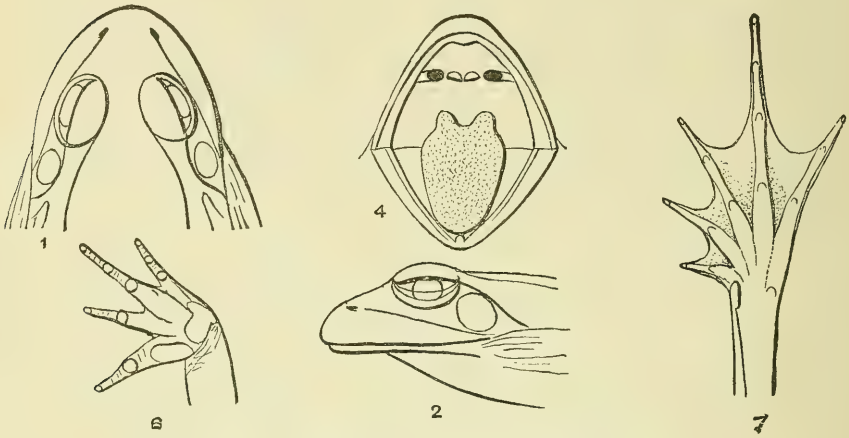


FIG. 103. *Rana areolata areolata.* No. 3304. Indianola, Tex.; ½

General shape slender and limbs elongated. The heel of the extended hind leg reaches half-way between orbit and nostril. Head about as broad as long; quite deep. Sides oblique, with the nostrils, as viewed from the side of head oblique, a little below the upper profile or canthus rostralis, and with a marginal papilla. A slight excavation between nostril and eye, continued under the latter, along upper edge of maxillary, to the tympanum, but scarcely below it. Top of the head slightly grooved, or concave longitudinally. Eyes large and prominent; in the middle third of the side of the head; nostril midway between it and tip of snout. Tympanum circular, not two thirds of the diameter of the eye, not extending back to angle of jaw, but nearer this than to eye, nearly smooth centrally. Upper maxillary large; no glandular ridge of skin on it. Very well-developed vocal vesicles on each side, their centers opposite the posterior end of mandible.

Internal nostrils very large, open, transversely elongate, with a very shallow groove extending to the side of the jaw. The vomerine teeth are well developed, on two oblique protuberances, nearly in contact behind, and placed between the nostrils, the posterior edges of which are about opposite the anterior canthus of the eye. The tongue is large, fleshy, longer than broad, with the cornua small and wide apart. The Eustachian apertures are moderate.

The upper parts generally are smooth, the sides apparently somewhat corrugated (scarcely pustular), though how much is owing to the alcohol can not be easily determined. The posterior, inferior, and superior faces of the thighs are granulated; this, however, not extending to the body, which is inferiorly entirely smooth. A rather broad but low fold of skin may be traced from above the tympanum along the back nearly to the thigh. A small ridge behind the tympanum.

The inner toe does not reach much beyond the middle of the metatarsal of the fourth. The web is but slightly developed; it extends fully only from the penultimate articulation of the outer to the antepenultimate of the fourth toe; from this to the penultimate of the third; from the middle of the third phalange of this (counting from tip) to the second articulation of second; from third joint of second to first joint of fifth; in each case extending a little beyond as a narrow marginal membrane. The terminal two and one-half phalanges of the longest toe, however, are almost entirely free, and one and one-half of the rest. The membrane is more cut out on the inner edges of the joints than the outer, by nearly one phalange. The cuneiform bone is slightly developed. No tubercle opposite on the outer edge of sole.

Upper parts brownish-olive, minutely and obsoletely mottled with lighter. The entire upper parts and sides are covered by a number of dark brown blotches, with light yellowish center; they are subcircular, and smaller than the tympanum. They are most distinct and crowded anteriorly, and do not invade the outer ridges of skin. The ground-color of the upper surface of the fore limbs and the sides of the head is yellowish-brown, with vermiculation of brown, as also some distinct blotches of the same on the former. The hind legs have numerous parallel and transverse dark brown bars, three or four on the thighs, four or five on the tibia, three on the tarsus, and several on the edge of the foot. These bars are broader than their interspaces, and are margined by a narrow yellowish line, so that the interval between two adjacent light lines exhibits a brown ground lighter than the dark bars just described, and also transverse. Indeed, they may be described as narrower bars of lighter tint between the dark bars, parallel to them, and separated by narrow yellowish-brown lines. The lower parts are yellowish-white, unspotted, including the interior and inferior surfaces of the limbs. A few scattered blotches are seen on the throat and chin. The buttocks are yellowish white, with a few obsolete dark blotches, smallest on the posterior edge. The central third of the tympanum is white.

	Inches.	
Body	3.00	1.00
Femur	1.25	.42
Tibia	1.45	.48
Tarsus	.75	.25
Hind foot	1.46	.49
Difference between shortest and longest toes	1.02	.34

	Inches.	
Total hind leg	1.48	4.44
Fore leg from elbow	.38	1.14
Hand	.23	.69
Width of head	.35	1.04
Chord of jaws	.35	1.06
Tympanum	.08	.23

Rana areolata areolata Baird & Girard.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3304	1	Indianola, Tex		J. H. Clark	Alcoholic.
11897	1	Nashville, Ga	1880	W. J. Taylor	Do.

Rana areolata aesopus Cope.

Proceed. Amer. Philosoph. Soc., 1886, p. 517.

This singular form may be known at once by the short and squat form of the body as compared with the size of the head, resembling in this some of the Australian Cystignathidæ.

The muzzle is not prominent, and does not project beyond the upper lip. The canthus rostrales are straight, and the top of the head is flat. The tympanic disk is a vertical oval, of which the short diameter is one-half the length of the eye. The edge of the vomerine patches of teeth are a little posterior to the line connecting the posterior border of the nares. The latter are about as large as the ostia pharyngea.

The dorsolateral glandular ridge is thick, and extends a little beyond the sacral diapophysis. There are six or seven rows of short longitudinal glandular tubercles in the space between them. There are similar elongate warts on the sides. The posterior and posteroinferior faces of the femora finely granular; rest of the inferior surfaces smooth.

The first finger is longer than the second, and equals the fourth. The heel of the extended hind leg reaches to the middle of the eye. The foot is of moderate length. Three of the phalanges of the fourth digit are entirely free, and the web is excavated to opposite the middle of the first phalange, extending as a margin on each side of the distal half. The inner cuneiform tubercle is not large, and has an acute apex; no external tubercle. A slightly defined tarsal dermal ridge.

In alcohol the ground-color is light brown, with the dorsolateral ridge and the inferior surfaces straw-color. The spots are a darker brown, and do not appear to have been yellow-bordered. The dorsal spots are irregularly rounded, and are in three or four longitudinal rows. There are two rows on the top of the muzzle and head, crossing the inner edge of the eyelid. There are two spots near the external edge of each eyelid. Spots on the sides smaller, in about four rows. The lores and upper lip are rather coarsely marbled with brown; gular region faintly speckled with the same. No band, but a spot on the front of the humerus; a spot on the elbow, and three cross lines on the fore-arm. Four narrow cross bars on the femur and five across the tibia. Three cross-bars on the external side of the tarsus and five on the external face of the fourth toe. The posterior face of the femur has numerous rounded brown spots on a light ground.

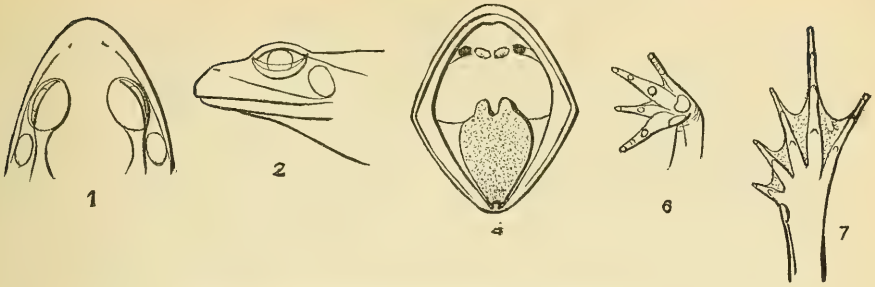


FIG. 104. *Rana areolata æsopus*. No. 4743. Micanopy, Fla.; ½.

Measurements of No. 4743.

	M.
Length of head and body	.062
Width of head at posterior edges tympana	.020
Length of head to posterior edges tympana	.024
Length of fore leg	.026
Length of fore foot	.012
Length of hind leg to groin	.074
Length of tibia	.024
Length of tarsus	.013
Length of rest of foot	.025

The only specimen of this subspecies which I have seen is the following:

Rana areolata æsopus Cope.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
4743	1	Micanopy, Fla		Dr. T. H. Bean	Alcoholic.

Rana areolata circulosa Rice and Davis.*

Rice and Davis, in Jordan Man. of Vert. East. N. Amer., ed. II, 1878, 355.

Two specimens of this form are before me and yield the following characters: Their peculiar coloration gives them an elegant appearance, and one quite different from that presented by any other North American Rana.

Length of head one-third of total. Heel of extended hind leg reaching to the front of the orbit; muzzle rather elongate, but little produced beyond the edge of the lip, the extremity sloping obliquely upwards and posteriorly, so as to shorten the superior plane. The nostril has an elevated position and a suprolateral presentation; it is a little nearer the orbit than the end of the muzzle. The membranum tympani is a vertical oval, with the short diameter only half the length of the eye fissure. The heel of the extended hind leg reaches to the anterior border of the orbit. The posterior edges of the vomerine patches are behind the borders of the choanæ.

*Plate 51, fig. 10.

There is a strong dorsolateral glandular ridge on each side, and between these there are from six to eight narrow glandular folds not so much broken up as in the *R. a. æsopus*, but readily becoming indistinct in alcohol. The dorsolateral fold extends nearly to the groin. Below it the sides are crowded with longitudinal glandular folds, more or less broken up.

The first finger exceeds the second and equals the fourth. The internal cuneiform tubercle is quite small, and has a free apex; no external tubercle. The web is shorter than in the other subspecies, being scalloped nearly to the line of the base of the first phalange, which it only margins for part of its length, ceasing near the distal end.

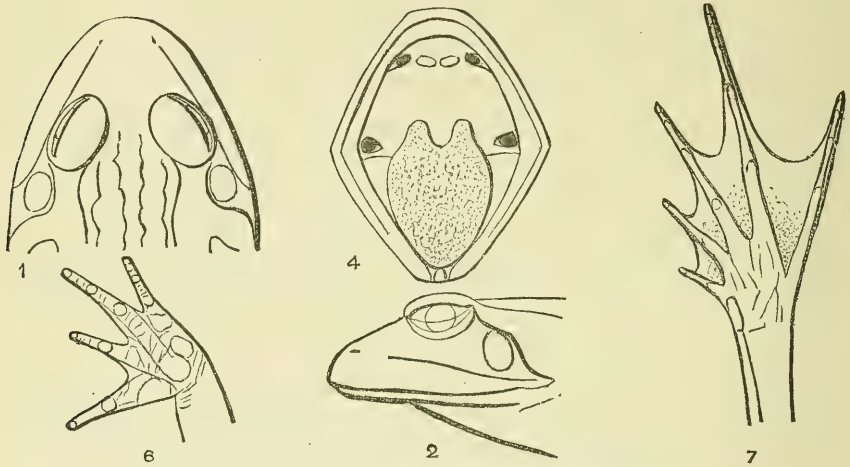


FIG. 105. *Rana areolata circulosa*. No. 278. Mus. Champaign, Ill.; ½.

Color in spirits, light brownish-yellow or straw-color, above and below. The entire upper surface and sides are, however, so thickly covered with large reddish-brown spots as to reduce the ground-color to a network, forming a pattern of numerous irregular or crenate circles. These are in three rows between the dorsolateral ridges, which are of the light ground-color for most of their length. There are no light bands or lines about the head, but the lores and upper lips are closely and rather coarsely marbled with brown and yellow. The lower lip is less distinctly marked in the same way. At the orbits there are three rows of large spots like those of the back, the exterior ones on the eyelids. The fore legs are marbled like the lores, with a faint suspicion of cross-bars. The thigh, tibia, tarsus, and external toe are cross-banded with such wide brown bars, that the interspaces are very narrow and often interrupted. There are three wide and two narrow bars on the thigh, and no longitudinal markings; there are six bars across the tibia of different widths, and three across the tarsus; inferior surfaces unspotted. The lateral spots become more sparse and more widely spaced near to the abdomen; thigh posteriorly with large brown spots, on a straw-colored ground.

Measurements of No. 9386.

	M.
Length of head and body	.050
Width of head at posterior edge of tympanum	.0195
Length of head to posterior edge of tympanum	.019
Length of fore leg	.022
Length of fore foot	.011
Length of hind leg to groin	.073
Length of tibia	.024
Length of tarsus	.014
Length of rest of foot	.025

Since the above was written I have been able, through the kindness of Professor Forbes, of the university at Champaign, Ill., to examine the type specimen of Messrs. Rice and Davis. It differs considerably from the specimens above described, as follows: The muzzle is not protuberant, so that the nostril is equidistant between the end of the muzzle and the eye, as in the subspecies Areolata. The tympanic disk is nearly round, and its long diameter is three-fourths that of the eye. This specimen has twice the bulk. In other respects it does not differ. A very strong glandular thickening of the skin extends from the eye above the tympanum, and then descends posterior to it. The eyelid also is thickened.

Two specimens (No. 13828) from Olney, Ill., also received since the above description was written, explain these discrepancies. The larger of the two agrees with the type in all respects, but the smaller, which about equals the type in dimensions, has the elongate muzzle of the small ones that I have described above. In both the tympana are three-fourths the orbit, and in neither is it decidedly oval.

Rana areolata circulosa R. & D.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
9386	2	Northern Illinois		Robert Kennicott	Alcoholic.
13828	2	Olney, Ill		John and Charles Walker	Do.

Rana areolata capito Le Conte.

Proceed. Ac. Phila., 1855, p. 425, Plate v.

Not having at hand the only known specimen of this form, I copy the description given by Le Conte. The proportions given by this author indicate that it is intermediate in proportions between the subspecies Æsopus and the others. Thus the width of the head in the latter enters the length 2.33 times, and in the *R. a. areolata* three times. In *R. a. capito* it enters 2.8 times. The spots are smaller than in *R. a. circulosa*, but larger and more numerous than in *R. a. æsopus* and *R. a. areolata*.

Above very rough, dark gray, or slate-color, speckled with black, with six rows of roundish rows on the back; sides speckled and irregu-

larly marked with spots of the same form and color; from the orbits to beyond the middle of the body runs a broad raised line or cutaneous fold, and another from the corner of the mouth to the insertion of the arm. Beneath smooth, yellowish-white, speckled, spotted, and varied with dusky; top of the head coarsely punctured, back and sides tuberculous. Head very large, broad, and blunt; a deep concavity between the nostrils and the eyes. Iris golden, mixed with black. Tympanum of the color of the body. Lower jaw with a small protuberance or point resembling a tooth. Arms and legs above gray, speckled, and barred with black; beneath yellowish-spotted and varied with dusky, the yellowish color more decided at the axillæ and groins. Hind part of the thighs granulate. Fingers slightly palmate at the base; the first longer than the second. The second toe twice as long as the first.

Rana areolata capito Le Conte.

RESERVE SERIES.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
5903	1	Riceborough, Ga		Maj. J. Le Conte	Alcoholic.

RANA SEPTENTRIONALIS Baird.

(Plate 86.)

Proceed. Ac. Phila., 1855, p. 51.

Garnier, American Naturalist, 1883, p. 945.

Rana sinuata Baird, *l. c.*

Body rather broad, stout, and depressed. Head rather narrow; nostrils large, midway between tip of snout and eye. Tympanum variable, at least half the diameter of the eye. Vomerine teeth minute; the patches are on a level with the posterior margin of the inner nostrils (which are rather large), and are separated by considerable intervals. Tongue moderate, the cornua well developed.

Skin rough and irregular above and on sides; not pustular nor tuberculated; beneath entirely smooth. Buttocks but slightly granulated. A well-defined, rather broad ridge commences behind the eye and, bifurcating, the short branch curves round the tympanum, passes obliquely down to the insertion of the arm, thickening in its descent, and meets a similar thickening from the rictus. These two ridges are separated by a groove, which commences at the eye and runs above and behind the tympanum. The main branch proceeds along the sides to about opposite the sacrum, where it is lost. No other ridges are to be seen.

The fore-arm is short, considerably less than the hand. The femur and tibia are about equal, less than half the length of body and less

than the hind foot. The first, third, and fifth toes are equal. The terminal joint of the second toe is free, as are the inner edges of the terminal joints of the second and third, and the outer edges are margined to near the tips. The cuneiform process is well developed, and the sole has no distinct tubercles.

Color above and on sides light olive, with short and coarse vermiculations of lighter, most distinct anteriorly. On the sides and lower half of the back are several subcircular, large blotches of dark brown. Legs with few blotches; no bands. Buttocks yellow, with short vermiculate dark blotches. Beneath uniform dull yellow. No light stripe on jaw.

Compared with specimens of *R. clamata* of the same size from the north, this species differs altogether in color, in larger eyes, longer fingers, longer but less webbed foot, etc.

	Inches.			Inches.	
Total length of body	1.92	1.00	Hind foot	1.02	.53
Fore-arm	.28	.14	Between outstretched arms	2.76	1.44
Hand	.50	.26	Chord of upper jaw	.70	.36
Femur	.97	.51	Width of upper jaw	.64	.33
Tibia	.99	.52	Eye	.26	.13
Tarsus	.46	.24	Tympanum	.15	.08
Hind leg	2.84	1.48			

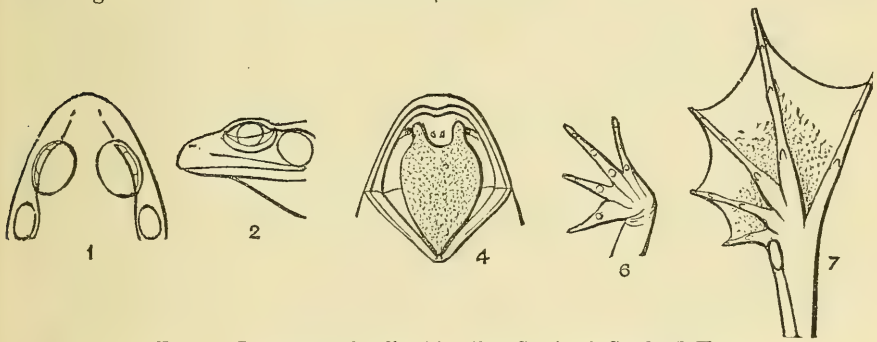


FIG. 106. *Rana septentrionalis*. No. 3420. Garrison's Creek, N. Y.; ½.

Mature specimens, formerly described under the name *Rana, sinuata,* present the following characters:

Body rather stout. Eyes large; tympanum three-fourths as large. Vomerine teeth small, ranging with the centers of inner nares. An indistinct fold of skin on each side of back; none intermediate; granulation of buttocks indistinct. Femur not half the length of body; hind foot considerably longer than the tibia. Above and on sides purplish-brown, with sinuations or coarse vermiculations of yellow. Beneath silvery white. Legs transversely barred.

Female.—Body moderately stout and depressed; limbs not much developed; femur and tibia about equal, not half the length of body. Head rather longer than broad. Nostrils nearly intermediate between the eye and tip of snout (projected on axis of body), or nearer the latter,

situated on the canthus rostralis. The hollow of the face anterior to the eye is very shallow, and scarcely traceable under the eye and tympanum. Eyes large; contained three times in chord of upper jaw and one diameter from the tip. Tympanum small (females only seen), about three-fourth the size of the eye; behind not reaching the end of the jaw. Patches of vomerine teeth very small, circular, approximated, and situated on a level with the centers of the inner nares. These are large, oblong, and widely separated. Tongue rather small, narrow. Eustachian ostia large.

The skin is moderately smooth, but on very close examination is seen minutely and closely dotted all over with small pits, and among these on the under surfaces are scattered small glandiform elevations, which on being emptied are represented by the pits. This is sometimes seen in other species, but seldom so distinctly, and may be caused by some peculiar and temporary condition of the skin. There appears to be a very low and scarcely distinct dermal ridge from the eye along the sides, but none intermediate. The granulation on the buttocks is very low and indistinct.

The fore-arm is shorter than the hand; the femur is not quite half the length of the body, and is about as long as the tibia. The hind feet are unusually long, considerably exceeding the tibia. The feet are very fully webbed, coming near *R. catesbiana* in this respect, the web extending between the tips of the toes, slightly excavated in the inner edges of the second and third. The terminal joint of longest toe appears to be entirely free and the second is rather narrowly margined.

In alcohol the color everywhere above and on sides (even over tympanum and on buttocks) is dark purplish-brown, coarsely and irregularly sinuated with bluish-white, which, as far as Professor Baird's recollection of several years goes, is yellow during life. Beneath, silvery-white on throat and chin; duller behind. The joints of the hind legs are distinctly banded transversely with dark blotches with bluish-white margins, as on the back, and separated by lighter intervals. The sides are darker than the rest of the body, and on the groin are seen a few light spots rather than sinuations.

The specimens described (all females) were caught in Garrison's Creek, near Sackett's Harbor, in the summer of 1850. They were in a marshy piece of ground, about a mile from the lake, and attracted immediate attention by their peculiarities of color, so different from any other American species:

	Inches.	
Total length	2.25	1.00
Arm from elbow	.90	.40
Femur	1.10	.49
Tibia	1.04	.46
Tarsus	.56	.25
Hind foot	1.18	.52

	Inches.	
Total	1.70	.76
Chord of head	.80	.35
Width of head	.75	.35
Eye	.27	.12
Tympanum	.20	.09

The variations of the *Rana septentrionalis* are greater than those of any other North American species of the genus. There is, however, no coin-

cidence between them, so that they can not be regarded as indicating subspecies. The tympanic disk varies greatly in size, the males having it larger than the eye, and the females smaller than the eye. In this respect the species displays its near affinity to the *R. clamata* and *R. catesbiana*. Some specimens have a dorsolateral dermal glandular ridge, and others have none, such difference being exhibited by specimens from the same locality. The spotting of the dorsal surfaces varies very much. In some specimens the spots are not closely placed; in others they leave only narrow lines of the lighter ground-color between them.

Taking all its characters together, this species occupies a position intermediate between nearly all the North American species of the genus, and from some such form it might be supposed that all the Ranæ of the northern hemisphere have been derived. The present distribution of the species is entirely northern.

Dr. J. H. Garnier has given a detailed account of the habits of this species as observed by him at Lucknow, Ontario. He calls it the mink frog, and says that it emits the odor of the mink on being handled. It is an aquatic species, never seeking its food, which consists of insects and small fishes, on land.

Rana septentrionalis Baird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3420	5	Garrison's Creek, N. Y.		Prof. S. F. Baird	Alcoholic.
3432	15	Madrid, N. Y.		do	Do.
13605	20	Lucknow, Ontario	1883	J. H. Garnier	Do.
13621	1	do	1883	do	Do.
13622	1	do	1883	do	Do.
5379	2	Selkirk Settlement		R. Kennicott	Do.
		Fort Ripley, Minn		Dr. J. F. Head	Do.

RANA CLAMATA Daudin.*

Hist. Nat., Reptil., VIII (1803), 104, 431; 1 b., Hist. Nat. Rain. (1803), 54, Pl. XVI, fig. 2; Harl., Sillim. Amer. Journ. Sci., X (1825), 63; 1 b., Journ. Ac. Nat. Sci. Phila., V (1827) 335; 1 b., Med. & Phys. Res. (1835), 101, 226; Dum. & Bibr. (Daud.), Erp. Gén., VIII (1841), 373.

Rana clamitans Daudin, in Sonn. & Lat. Hist. Nat., Reptil., II (1802), 157; Merrem, Tent. Syst. Amph. (1820), 175; Holbr. (Bosc.), N. Amer. Herp., 1st ed., III (1838), 89, Pl. XVII; *Ib.*, 2d ed., IV (1842), 85, Pl. XX.

Rana fontinalis Le Conte, Ann. N. Y. Lyc., I (1825), 282; Holbr., N. Amer. Herp., 1st ed., III (1838), 85, Pl. XVI; 1 b., 2d ed., IV (1842), 87, Pl. XXI; Storer, Mass. Rept., Reptil. (1839), 236; Thompson, Med. Hist. Mass. (1842), 120; De Kay, N. Y. Zool., III (1842), Pl. XXI, fig. 54, A.

Ranaria melanota Rafin., Annals of Nature (1820), No. 25 (Lake Champlain).

Rana melanota (Rafin.) Harl., in Sillim. Amer. Journ. Sci., X (1825), 64; Journ. Ac. Nat. Sci. Phila., V (1827), 336; 1 b., Med. & Phys. Res. (1835), 102, 228; Thompson, Nat. Hist. Vt. (1842), 121.

*Plates 51, figs. 2–3; 75, figs. 19, 33.

Rana flaviviridis Harlan, in Sillim. Amer. Journ. Sci., x (1825), 58; 1 b., Journ. Ac. Nat. Sci. Phila., v (1827) 338; 1 b., Med. & Phys. Res. (1835), 103, 220.

Rana horiconensis Holbr., N. Amer. Herp., 1st ed., III (1838), 91, XVIII; 1 b., 2d ed., IV (1842), 91, XVIII; Thompson, Nat. Hist. Vt. (1842), 121; De Kay, N. Y. Zool., III (1842), 61, XXII, fig. 62.

Rana nigricans Agassiz, Lake Superior (1850), 379, VI, figs. 4, 5.

Male.—Body and limbs very stout and massive; not much depressed. Legs short; head subacute, rounded, very deep. Nostrils large, oval; situated on the rounded and indistinct canthus rostralis, nearest to the snout, and distant from the orbit by half the diameter of the eye. Excavation anterior to the eye shallow, scarcely distinct in passing under the eye to the tympanum. Tympanum very large, one-fourth greater than the eye, and extending quite up to it, and passing beyond the articulation of the jaw; one-half the length of line from commissure to the tip of snout; its central third elevated in a shallow prominence. Eyes large, contained two and three-fourth times in chord of lower jaw and two and one-fourth in that from commissure. Head rather larger than broad.

In the female the tympanum is much smaller, though still large; about three-fourths diameter of eye, and distant from the latter by nearly half its own diameter. The average diameter in males is 11^{mm}, and in females 8^{mm}. Occasionally this character does not hold good. A male (No. 3462) has the diameter only 8^{mm}, while three females (Nos. 3467, 3475, and 3524) have disks of 10^{mm} in diameter. In this species and in the *R. catesbiana* this membrane reaches a larger size than in any other species of Batrachia.

The top of the head is plane, without any concavity. The tongue is large, fleshy, rather narrow, and free behind for one-fourth its length. The interior nares are large, and open posteriorly nearly opposite the anterior canthus of the eye. The vomerine teeth are in two oblong patches, inclined backwards, where they are nearly, if not quite, in contact, and posterior to the posterior margin of nares, though anteriorly about on a line. Eustachian openings large.

Skin more or less mammillated above and on the sides by coarse pustuliform prominences, largest on the sides; these occasionally are in the form of regular asperities, rough to the touch; the amount of this, however, depends somewhat on the conditions of preservation. From the eye extends a prominent ridge of skin, which, after passing above the center of the tympanum, bifurcates, one short branch passing round the tympanum, and, thickening below, stops above the shoulder; beneath this for its whole length passes a well-defined furrow indenting the fold, and, proceeding directly downwards, separates the thickening just described from a corresponding and equal thickening just behind the jaw. The long branch of the ridge or fold of skin behind the eye proceeds along the sides, occasionally interrupted, and is lost on the posterior fourth of the body, those of opposite sides parallel and wide

apart. There are no other ridges of skin as observed in *R. palustris;* but a distinct broad groove or furrow may be traced down the middle of the back.

The fore-arm and hand are of nearly equal length; the third finger longest; the first and fourth nearly equal, and longer than the second. The hind legs are short; the tibia, femur, and hind foot about equal, and less than half the length of the body. The third toe is longer than the fifth. The web between the toes is well developed, and extends from the terminal knobs, except on the inside of the second and third toes, where it is excavated to the first articulation. The first and second joints of the longest toe are not webbed, but are narrowly margined to the tips.

The general color, as preserved in alcohol, is of a dull greenish-brown or brownish-olive, with simple subcircular blotches on the back, sides, and buttocks, and indistinct, sometimes much broken fasciæ on the limbs. There is in some an obscure yellowish line along the sides of the jaw and reaching to the arm, and a dark mark from the commissure to the arm beneath this line. The edges of the jaw are blotched with brown; beneath, yellowish-white. In other specimens the blotches above are finer and more crowded, and the chin and throat coarsely reticulated or blotched with brown, the same marking visible obsoletely on the under surfaces of the thighs. The blotches of sides of body are sometimes much larger and more distinct than elsewhere.

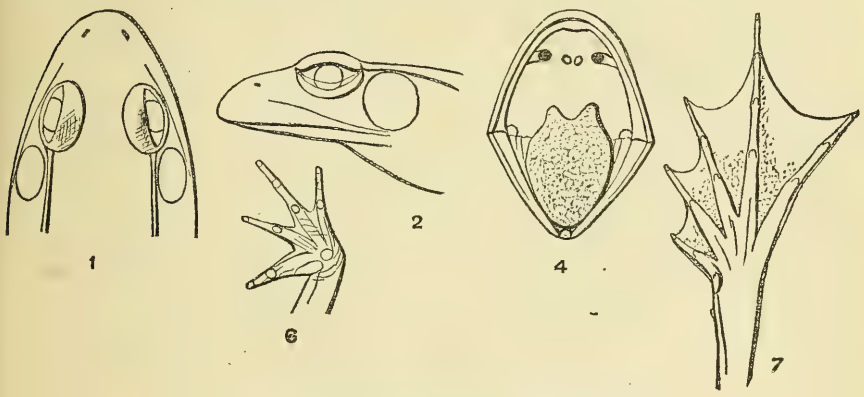


FIG. 107. *Rana clamata.* No. 3501. Eutaw, Ala.; ½.

The bars on the legs are sometimes replaced entirely by small blotches. The females, as already stated, differ in having a smaller tympanum, though neither here nor in the males is the proportional size always the same. The body is more swollen behind; the head narrower and not so deep, and the thumbs less thickened.

In life this species is dark olive posteriorly above, which color gradually passes into a brilliant green anteriorly. Below, white; the throat citron yellow.

Male.

	Inches.			Inches.	
Total length	2.96	1.00	Total of hind foot	4.70	1.59
Arm from elbow	1.20	.40	Chord of head	1.14	.38
Femur	1.40	.47	Width of head	1.10	.37
Tibia	1.40	.47	Tympanum	.47	.16
Tarsus	.76	.26	Eye	.38	.13
Foot	1.46	.49			

Female (Carlisle, Pa.).

Total	3.30	1.00	Total of leg	5.00	1.51
Femur	1.55	.47	Tympanum	.32	.10
Tibia	1.55	.47			

A Carlisle, Pa., specimen, when living, was colored as follows: Above and on sides, greenish-brown, with rounded brown spots uniformly distributed, and about as large as the pupil of the eye; about twenty between the lateral folds; head and body anteriorly bright grass-green; beneath greenish-white, unspotted, the color of the sides fading into it; the buttocks mottled with brown and yellowish white; femur and leg with three or four transverse dark bands; fore limbs with scattered blotches not banded; iris black, mottled with golden.

The specimens from Lake Superior are types of the *R. nigricans* of Professor Agassiz, which I can not distinguish. They exhibit a greater amount of black mottling and blotches on the inferior surface than usual, but this is shared by individuals from more southern localities. Specimens from Maine and Louisiana are still darker, the buttocks being nearly uniform black.

In carefully comparing quite a number of specimens from the South and North, I find it impossible to establish definite characters by which to distinguish a *R. fontinalis* from *R. clamata*. At first sight the Southern individuals, which happened all to be of medium size, appeared to be more free from the coarse pustulations; but on the other hand to have the fine asperities more numerous and closer and the head rather narrower; but the same conditions were seen in some Northern specimens. The tympanum is very large in the males, though varying with the individuals. As in the Northern specimens, some are nearly immaculate; others mottled above and below, and of various shades of color, from black above to olivaceous.*

This is especially a species of an aquatic life, not hunting on land, but haunting all kinds of waters, from springs to river banks. It lives singly, in pairs, or in small companies, but never in swarms like the *R. virescens*. It is not noisy, contenting itself with an occasional nasal "chung," and frequently uttering a sharp cry as it plunges into the water to escape the pedestrian on the bank. It is a good leaper and swimmer.

* Professor Baird had an opportunity of examining the specimens from which Dr. Holbrook made his description and figure of *R. clamitans* without seeing occasion to change the opinion above expressed.

Rana clamata Daudin.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3502	6	Pensacola, Fla		Dr. J. F. Hammond, U. S. A.	Alcoholic.
3466	7	Root R., Racine, Wis		Prof. S. F. Baird	Do. ♀
3462	7	do		do	Do. ♀
3478	8	Madison, Wis		do	Do. ♂
3489	1	Fond du Lac, Wis		Rev. A. C. Barry	Do.
3473	4	Rochester, Wis		Prof. S. F. Baird	Do. ♀
3483	2	Aztalan, Wis		do	Do. ♀
3479	1	Waukesha, Wis		Rev. A. C. Barry	Do.
3469	5	Elizabethtown, N. Y		Prof. S. F. Baird	Do. ♂
3464	4	Westport, N. Y		do	Do. ♀
3488	5	Washington, D. C		J. H. Richard	Do.
3468	6	Carlisle, Pa		Prof. S. F. Baird	Do. ♀
3477	1	do		do	Do.
3465	9	do		do	Do. ♂
3475	2	Meadville, Pa		Prof. Williams	Do. ♀
3543	1	do		J. F. Thickston	Do.
3472	3	Quebec, Canada		Prof. S. F. Baird	Do. ♂
3487	2	Mount Holly, N. J		do	Do.
3541	1	Cumberland County, Md.		do	Do.
3486	1	Clarke County, Va		Dr. C. B. R. Kennerly	Do. ♀
3499	2	Prairie Mer Rouge, La		James Fairie	Do.
3501	2	Eutaw, Ala		Prof. A. Winchell	Do. ♀
3470	5	Port Huron, Mich		Prof. S. F. Baird	Do. ♀
3467	5	Detroit River, Mich		do	Do. ♀
3500	4	Anderson, S. C		Miss C. Paine	Do. ♂
3482	5	Kennebago, Me		Prof. C. Girard	Do. ♀
3476	1	Portage County, Ohio		Prof. S. F. Baird	Do.
3485	1	Columbus, Ohio		Prof. L. Lesquereux	Do.
3474	1	Highland County, Ohio		Fred. Mather	Do. ♀
3435	1	Southern Illinois			Do.
3593	1	Weathersfield, Conn		C. Wright	Do.
3526	1	Salem, N. C		J. T. Lineback	Do.
3492	1	Aux Plaines River, Ill		R. Kennicott	Do.
3493	1	Willow Creek, Wis		Rev. A. C. Barry	Do.
3503	8	Missouri		Dr. P. R. Hoy	Do. ♀
3524	4	Southern Illinois		R. Kennicott	Do. ♀
9468	1	Ferry Landing, Va	May—, 1875	H. W. Henshaw	Do.
9732	6	Southern Illinois		R. Kennicott	Do. ♀
9391	17	Upper Wisconsin River.		do	Do.
13606	3	Lucknow, Ontario		J. H. Garnier	Do.
3693	1	Weathersfield, Conn		C. Wright	Do.
13594	[illegible]	(?)		(?)	Do. ♂
3521	1	Meadville, Pa		J. F. Thickston	Do.
3515	1	Western Mississippi		Dr. P. R. Hoy	Do.
3518	2	Saint Louis, Mo		Dr. George Englemann	Do.
5374	1	South of Highland, Canada.		C. Drexler	Do.
11532	1	Michipicoten, Lake Superior.		G. Barrister	Do.
1062	3	Carlisle, Pa		Prof. S. F. Baird	Do.
11396	2	Milton, Fla	1881	S. T. Walker	Do.
11476	2	Waukegan, Ill		James Milner	Do.
11908	1	Nashville, Ga	1880	W. J. Taylor	Do.
11491	3	(?)		(?)	Do.
11445	1	Wood's Holl, Mass	1885	U. S. Fish Commission	Do.
3335	6	Southern Pacific Railroad Survey.		H. B. Mollhausen	Do.
3528	1	Madrid, N. Y		Prof. S. F. Baird	Do.

RANA CATESBIANA Shaw.*

Rana catesbiana Shaw, Gen. Zool., III, Amphibia (1802), 106, Pl. XXVIII; Le Conte, Proceed. Ac. Phila. (1855), p. 423.

? *Rana boans* Lacep., Hist. Nat. Quad. Ovip. (1st ed. 1798 ?), ed. Deterville, I (1819), 270, 315.

Rana pipiens Harl. (*nec* Linnæus), Sillim., Amer. Journ. Sci., X (1825), 62; *Ib.*, Journ. Ac. Nat. Sci., Phila., V (1827), 335; *Ib.*, Med. & Phys. Res., 1835, 101, 225; (Lat.) Holb. N. Amer. Herp., 1st ed., III (1838), 81, Pl. (e.c.), XV; *Ib.*, 2d ed., IV (1842), 77, Pl. XVIII; (L) Storer, Mass. Rept. (1839), 235; (L) Thompson, Nat. Hist. Vt. (1841), 119; De Kay, N. Y. Zool., III (1842), 60, Pl. XIX, fig. 48; Cuvier, Regne Animal, II, 106; illustrated ed. D'Orb., Pl. XXXVII, fig. 2; Baird & Girard, Reptil., Captain Marcy (1853), 243.

Rana mugiens Merrem, Tentamen Syst. Amph. (1820), 75; Gravenhorst, Del. Mus. Vratisl. (1829), 40; (Catesby) Dum. & Bibr., Erp. Gén., VIII (1841), 370; Wagl., Syst., p. 203; Tschudi, Batr., p. 79.

Rana scapularis Harl., Sillim., Amer. Journ. Sci., X (1825), 59; *Ib.*, Journ. Ac. Nat. Sci. Phila., V (1827), 338; *Ib.*, Med. & Phys. Res. (1835), 103, 221.

Rana maxima americana aquatica Catesby, Carol., II, 1743, Pl. —, p. 72 (not *Rana mugiens*, as quoted by Dum & Bibr.).

Rana conspersa Le Conte, Proceed. Ac. Phila., 1855, p. 425.

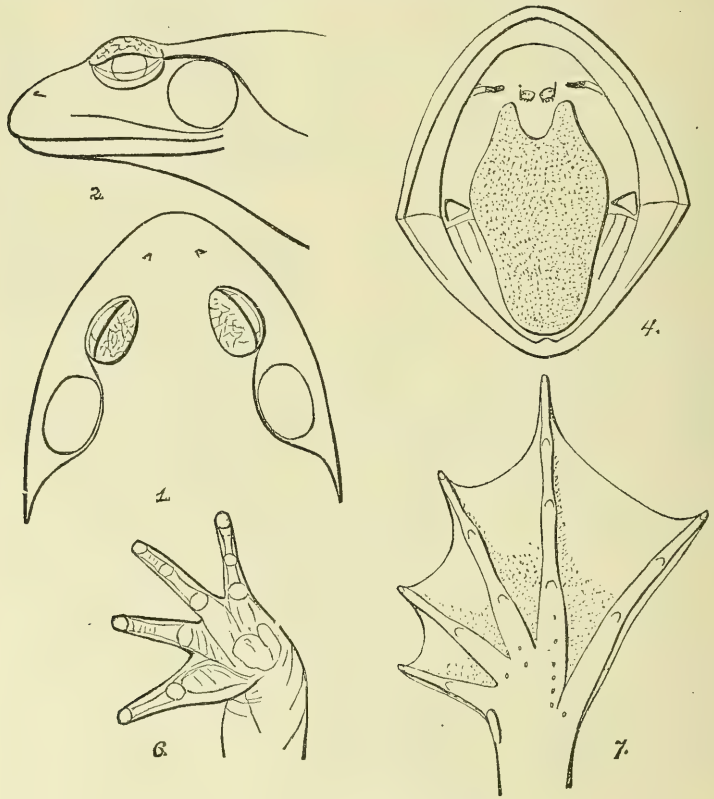


FIG. 108. *Rana catesbiana*. No. 11499; ½.

* Plates 50, fig. 3; 51, figs. 4–8; 55, figs. 6; 66; 67.

Largest of all the North American species. Body very bulky and clumsy; legs thick and short. Jaws nearly, if not quite, as wide as the length of chord of upper jaw and wider than the longitudinal axis of head; muzzle subtruncate; sides oblique. Nostrils oblique, a little below the edge of the canthus nostralis, half way between the tip of snout and anterior canthus of eye. Tympanum large, slightly oval, longer diameter somewhat oblique, equal to the diameter of the eye; granulated and slightly raised for the central two-thirds; smooth exteriorly. Internal nares elliptical, transverse, wider apart than are the external; their centers opposite a point about one-third from the eye to the outer nostril; a shallow groove extending to the rami of the jaw. Vomerine teeth in two patches, with four or five teeth in each patch; the bases of these anteriorly opposite the centers of the inner nostrils, and separated from each other by the same interval as from the nares. Eustachian tubes large, nearly opposite the centers of tympanum. Tongue elongated, broadest at the stem.

A fold of skin extends from the posterior canthus of the eye above the tympanum, and curving round it proceeds directly downward to behind the posterior extremity of the lower jaw; it then passes around the insertion of the fore-arm (distant about half the diameter orbit) and is lost on the breast. This fold is only conspicuous to the lower end of the tympanum; it is accompanied all the way by a groove on its lower edge, both being scarcely traceable beyond the point above mentioned, except in very well preserved specimens. There are no other folds of skin; especially none on the side of the back. The skin above is slightly shagreened by moderate asperities, which increase posteriorly. Beneath smooth. The posterior faces of the buttocks rugose-granulated.

The third finger (the second from outside) is longest, then fourth, first, and second. All are without any membrane or web. The tibia is not quite half the length of body. The fourth toe is longest; the third rather longer than the fifth; then second and first. All are cleft (except as to membrane) nearly to the base of the metatarsals, deepest along the first and fifth. The web fills up the entire interval, extending from tip to tip of the toes; the outlines nearly straight when outstretched.

The color above is olivaceous-brown, with darker blotches about half the diameter of the eye distributed pretty uniformly; occasionally in contact and confluent; the outlines obsolete or not clearly marked. The buttocks are similarly marked, with the blotches nearly black. The joints of the fore leg have each one or two bars or blotches; these are more distinctly transverse on the hind legs, where there are three or four on each joint. Membrane of hind foot finely mottled. The lower parts, including groin, are silvery white, with similar coarse blotches or mottlings of obscolescent brown, though not quite so much crowded as above; this pattern pervades the whole inferior and interior faces of body and limbs, leaving no portion unmarked. The tympanum is rather darkest in the center.

In the male the tympanum is much larger than in the females, and larger than the eye, extending to the posterior end of the jaw. In the males the diameter of the tympanic disk is about 20mm, reaching 25mm in large animals. In the female the diameter is about 11mm; but I have observed a male with the diameter only 10mm and a female with the diameter as large as the average of males. Such cases are, however, not very common. It may be observed here that the supposition, apparently entertained by some writers, that the *R. clamata* possesses the largest tympanic disk in the genus, is not correct, as it is as large in the present species.

The largest specimen of this species in the National Museum is the No. 10880, from South Carolina. Its dimensions are as follows:

Measurements No. 10880.

	M.
Length of head and body	.190
Width of head at posterior edges tympanic disk	.070
Length of head to posterior edges tympanic disk	.065
Diameter of tympanic disk	.025
Length of fore leg from axilla	.091
Length of fore foot	.040
Length of hind leg from groin	.238
Length of tibia	.074
Length of tarsus	.041
Length of remainder of hind foot	.080
Total expanse of palmation	.080

A large specimen from Pensacola has the head rather more elongated, being longer than broad; the tympanum normal. The palatine teeth are in two patches, close together; the prominences of bone on which they are situated are in contact at their bases; the tongue broad, short, and with long cornua. The skin is minutely shagreened above; less so beneath. The toes rather long. Body less blotched beneath, especially on the abdomen.

Measurements.

	Inches.			Inches.	
Total length	4.40	1.00	Total hind leg	6.70	1.52
Femur	2.10	.48	Arm from elbow	1.80	.41
Tibia	1.90	.43	Chord of upper jaw	1.72	.39
Tarsus	.66	.15	Width of head	1.66	.38
Hind foot	2.16	.49			

Most specimens from Carlisle, Pa., agree in general characters with the one described, although one has the skin more pustular, with the upper parts of an obscure ferruginous color, obsoletely varied with olivaceous. The head, too, is decidedly longer than broad. Another specimen, 4 inches in the length of body, with broad head, has the upper parts olivaceous green, with quite small indistinct blotches of purplish-brown, not very close to each other. Young specimens generally are of this color, the blotches reduced to distinct black dots, scattered uniformly over the back, and the lower parts yellowish anteriorly, with very obsolete indications of the blotches. Tympanum very large. The *R. conspersa* Le Conte was based on such a specimen.

In the North, associated with specimens of the dark-blotched variety, are others, some of considerable size, with the skin quite smooth, and not at all pustular. Broad head, above yellowish-green, without spots or bands anywhere; beneath yellowish-white; throat bright yellow. Others again show blotches on the buttocks, then on the inside of the legs, then elsewhere. It is impossible to draw out any constant characters whereby to define any one condition of marking; much depends upon the locality.

The young specimens as a general rule have the head narrower than the adults, and it must be borne in mind that the tadpole sometimes attains a very great size before any transformation is effected. The poin at which this takes place doubtless affects the general proportions.

Small specimens from Fort Smith, two and one-half inches long, are similar to those from Carlisle, Pa. Skin pustular.

Rana catesbiana Shaw.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3532	1	Carlisle, Pa		Prof. S. F. Baird	Alchololic.
3513	1	Lancaster County, Pa		do	Do.
3531	3	Foxburgh, Pa		Shaw	Do.
4835	1	Brookville, Pa		Dr. R. Haymond	Do. ♂
3337	1	Red River, Ark		Capt. R. B. Marcy, U. S. A.	Do. ♂
3321	2	Fort Smith, Ark		Dr. B. F. Shumard	Do.
3539	1	Prairie Mer Rouge, La		James Fairie	Do.
3510	1	Saint Louis, Mo		Dr. G. Englemann	Do.
3512	1	Riceborough, Ga		Prof. S. F. Baird	Do.
3514	1	Racine, Wis		do	Do.
3688	3	Pensacola, Fla		Dr. R. W. Jeffrey	Do. ♀
5917	1	Micanopy, Fla		Dr. T. H. Bean	Do.
3691	1	Tarborough, N. C		J. L. Bridger	Do.
8346	2				Do.
5508	1	Charleston, S. C		Prof. S. F. Baird	Do.
3340	1	San Diego, Cal		Lieut. B. Couch, U. S. A.	Do.
3534	3	Seneca Lake, N. Y			Do. ♂
3507	4	Elizabethtown, N. Y			Do.
3533	3	Westport, N. Y		Prof. S. F. Baird	Do. ♀
3538	1	Columbus, Ohio		Prof. L. Lesquereux	Do.
3711	1	Marietta, Ohio		Prof. E. B. Andrews	Do.
3508	1	Elyria, Ohio		Prof. S. F. Baird	Do.
3687	1	Mobile, Ala		Pilchody	Do.
3690	2	Western Missouri		Dr. P. R. Hoy	Do. ♀
3338	1	Goat Creek		H. B. Mollhausen	Do.
3336	1	Shawnee Village		do	Do.
9392	2	Shawnee Mission		Dr. J. G. Cooper	Do. ♀
9393	1	Monticello, Miss		Miss Helen Tennison	Do.
3331	3	Sibley Lake		W. S. Wood	Do.
3332	1	Saint Louis, Mo		do	Do.
3529	1	Tyree Springs, Tenn		Prof. R. Owen	Do.
3350	1	Yellowstone River		Dr. F. V. Hayden	Do. ♂
9469	1	New Orleans, La	May 29, 1875	New Orleans Academy	Do.
12069	1	Mount Carmel, Ill	Nov. —, 1881	L. M. Turner	Do.
9475	1	St. John's River, Fla	—, —, 1874	G. Brown Goode	Do.
3509	1	Black River, Elyria, Ohio		Prof. S. F. Baird	Do.
10880	1	Oakley, S. C		F. W. Hayward	Do. ♂
9389	1	Liberty County, Ga		Maj. J. Le Conte	Do.
9259	1	Washington, D. C	—, —, 1877	Dr. T. H. Bean	Do.
11514	2	(?)		(?)	Do.
10346	1	Arlington, Va	—, —, 1879	William Palmer	Do.
11499	2	(?)		(?)	Do. ♀♂
10099	1	Southhampton County, Va.	—, —, 1879	L. Kumlien	Do. ♂
14441	2	Wytheville, Va	—, —, 1885	Col. M. McDonald	Do.
3335	12	S. P. R. R. Survey		H. B. Mollhausen	Do.
3548	2	Southern Illinois		R. Kennnicot	Do.
	1	Framingham, Mass		S. F. Baird	Do.
	1	Montreal, D. C		do	Do.

This species prefers larger bodies of water, and especially haunts the shores where thickets and underbrush make them inaccessible. Its voice is familiar to all dwellers in the country, having much the tone of that of a bull, but with a better-defined enunciation. It may be imitated by uttering a bass "br'wum" several times in succession, with a hoarse voice, in front of an empty cask or other reverberating cavity. Familiar imitations of it are the words "be drowned" or "more rum." The voice is not uttered until the arrival of warm weather, and is continued during the evening throughout its continuance. It may be heard for a distance of several miles.

Dr. J. H. Garnier* points out the relationship between this species and the *R. clamata* and *R. septentrionalis*, in the following language:

"(1) They have no chant amour, or love notes, in spring. (2) They retire early to hibernate with the first autumnal frost. (3) They live in the water and lie in wait for their food, but do not hunt for it on land. They poise the body on any floating weeds, lie on the bank or any bit of stick or log that suits their purpose. (4) The tadpoles of *R. catesbiana* and *R.clamata* require two years to mature, and the 'mink frog' (*R. septentrionalis*) requires the same period. (5 and 6) The foot is broader in proportion than in the rest of the family (? genus), and the second toe is proportionally stouter, a peculiarity emphatically distinct, which can be seen at a glance. (7) When captured they sometimes utter a cry of distress quite different from their ordinary croaking notes, and I have often seen the bull-frog (*R. catesbiana*) open his mouth and scream for over a minute. (8) When they give their note it is always produced by inflating the throat-pouch and suddenly expelling the air, whereas in *R. virescens*, etc., there is a pouch near the angle of the jaws, on either side. (9.) They are all tinged more or less with yellowish-green on the chin, which soon shades towards the throat and breast, and the belly is white, or nearly so."

RANA MONTEZUMÆ Baird.†

Rana montezumæ Baird, Proceed. Ac. Phila., 1855, p. 61; Girard, U. S. Mex. Bound. Surv., Reptiles., p. 27, Pl. 36, fig. 1–6; Brocchi, Miss. Sc. Mex. Batr., p. 14, Pl. IV, fig. 2.

The general form is rather squat and heavy; in this respect resembling the Northern bull-frog, or *Rana catesbiana*. Like it, it is without any lateral ridge of the skin on the back, or if such be present, it is interrupted and soon disappears. The head is depressed, the angles all rounded, canthus rostralis not distinct; the nostrils situated a little below its highest part, about half-way between the eye and tip of snout. The top of the head is slightly convex between the eyes, without any groove. There is a slight depression behind and below the exterior nostrils, and which, proceeding backwards, becomes obsolete below the anterior canthus of the orbit and then reappears below the middle

*American Naturalist, 1883, p. 948. †Plate 51, fig. 12.

of the eye, whence it passes along the upper edge of the maxillary bone as a well-defined groove extending beneath the tympanum. There is no fold of skin passing over and behind the tympanum, as in *R. catesbiana*. The tympanum is moderate, subelliptical, with the longest diameter longitudinal, the center above the angle of the mouth, its anterior edge reaching within one-third of a diameter of the eye from the eye. The rim is well defined, being slightly raised above the level of the tympanum itself, which is nearly smooth, exhibiting only a slight granulation in the center. The tongue is broad, short, subor-

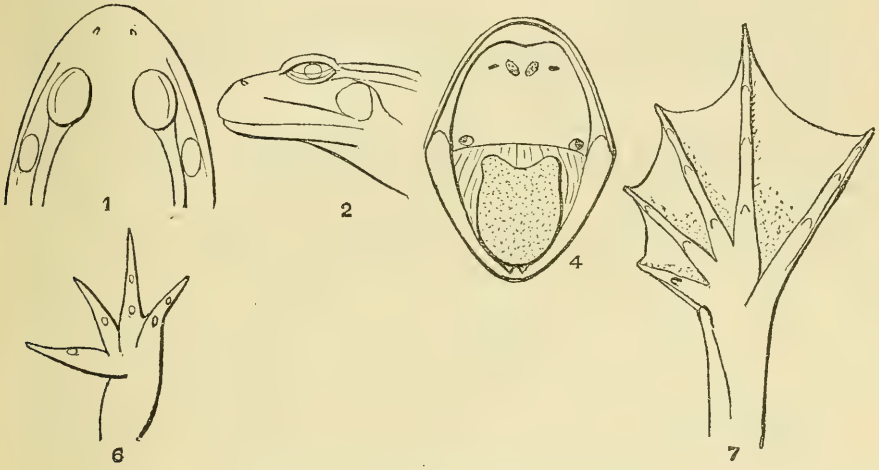


FIG. 109. *Rana montezumæ*. Valley of Mexico; ½.

bicular, and with the cornua distant and quite small; it is free on the sides and behind for two-thirds its length. The internal nares are small, transverse, exteriorly produced into a groove extending somewhat obliquely backwards to the edge of the maxillary bones; their centers nearer the anterior canthus orbitalis than to the exterior nostrils. The vomerine teeth are situated on two protuberances, which are inclined backwards at an acute angle, and placed with their anterior bases in a line with the anterior edges of the internal nares; the teeth themselves are few in number, minute, and range obliquely on the posterior portion of the crest of the protuberances. The teeth on the edge of the upper jaw are well developed, and extend to the inner edge of the angle of the mouth. The Eustachian openings are large, and at least twice the diameter of the choanæ. An external vocal vesicle of considerable size is seen on each side at the angle of the jaws, as large as a very large pea after being contracted by alcohol.

As already stated, there are two distinct ridges of skin, one on each side the back, commencing above the tympanum. They are frequently interrupted, and do not reach the groin. The upper parts are generally smooth, but with warts on the sides of the body, where they are flattened at top; occasional warts are scattered over the back,

though not prominent, but smoothed over. The buttocks are apparently smoother than common, the usual granulation being scarcely discernible. The under parts are entirely smooth.

The fingers are all free and of rather unusual length, and taper suddenly from the swollen base. The third is longest, the first and fourth nearly equal, though the latter is rather longer. The fourth toe is longest, fifth and third rather shorter. All the terminal phalanges are curved downwards and taper to rather an acute tip; the web is more cut out on the inner edges of the toes than on the outer; on the latter it extends to a little beyond the middle of the last phalange; on the former scarcely beyond the last joint; it is everywhere decidedly concave when stretched. The cuneiform tubercle is small, and there is a slight membrane extending from it along the inner edge of the foot.

The general color above is of a purplish-brown, beneath grayish-white or ash, everywhere minutely blotched or vermiculated with spots and sinuations of lighter; sometimes more in irregular spots, sometimes more in vermiculations. Beneath, these light spots are obsolete towards the chin, but they are very distinct on the side about the groin, and on the thighs anteriorly, posteriorly, and inferiorly, where they are larger than their interspaces. In the typical and best specimen the ground-color of the entire limbs is purplish-brown, rather lighter beneath and internally, with the lighter spots scattered everywhere, and very obsolete indications of transverse bars above. This appears to be a male.

A female still larger than the specimen upon which the description has been based is more squat in appearance, with the warts more distinct on the side and back, but with little or no granulation on the buttocks. The colors are much the same, except that the lower parts are lighter, the interior faces of the hind legs especially, which are yellowish-gray, with the light blotches very obsolete. The light spots in the groin are of a pink color, which may be the general hue of the spots. Length of body, 3.60 inches.

We have thus described one extreme of coloration. The other is quite different. Here the upper parts and sides are covered with very dark brown blotches, each with a lighter areola; the blotches average about two-thirds the size of the tympanum. Some of the blotches on the back are considerably elongated; those on the sides smaller. The ground-color is of a light olivaceous-brown, with a general and uniform mottling of lighter, as already described. The inferior parts are lighter, with the blotches more obsolete. The fore limbs with several obsolete dark blotches, the hinder with three or four transverse bars on each division; those on the thigh very short. Body 2.44 inches long.

Specimens are found in every stage of coloration between these extremes. Sometimes the blotches and bars are barely perceptible when the skin is wet, and again they are more distinct or not at all visible. The smaller specimens are usually the most blotched, the color becoming more uniform with increasing size. During life the dorsal spots

may become a grass-green. In most specimens the obliquity of the palatine protuberances is less than described.

The areolated varieties bear some resemblance to *R. areolata*, Baird and Girard, but may be distinguished by the white spots on the darker ground of the under and inner surfaces, the more fully webbed toes, the shorter limbs, etc. Both have the lateral vocal vesciles. *R. areolata* has a decided lateral fold.

Male.

	Inches.			Inches.	
Total length	3.20	1.00	Hand	.74	.23
Thigh	1.40	.44	Hind leg (stretched)	4.84	1.51
Tarsus	.70	.22	Length of head	1.08	.34
Hind foot	1.64	.51	Width	1.08	.34
Fore-arm, from elbow	1.70	.53	Length of eyelid	.30	.09

City of Mexico—twelve specimens, Maj. W. Rich; six specimens, E. D. Cope.

This species is common in the valley of Mexico, where it is used as food. The unspotted brown variety is found near Guanajuato; Dr. A. Dugés.

RANA TEMPORARIA Linn.

Rana temporaria, part., L. Syst. Nat., ed. 12, p. 357.
Rana muta Laur., Syn. Rept., p. 30.
Rana temporaria Schneider, Hist. Amph., I, p. 113; Latr., Sal., p. 37, and Rept. II, p. 150; Shaw, Zool., III, p. 97; Daud., Rain., p. 46, Pl. 15, and Reptil., VIII, p. 94; Merrem, Tent., p. 175; Penn., Brit. Zool., III, p. 9; Jenyns, Brit. Vert., p. 300; Bonap., Faun. Ital.; Schinz, Faun. Helv., p. 143; Tschudi, Batr., p. 79; Bell, Brit. Reptil., p. 84; Dum. & Bibr., p. 359; Koch, Ber. Senck. Ges. (1872), p. 135; Fatio, Vert. Suisse, III, p. 321; De Betta, Faun. Ital. Rett. Auf., p. 64; Lessona, Atti Ac. Lincei, Mem. Cl. Sc. Fis., I, p. 1068, Pl. II; Boulenger, Cat. Batr. Sal. Brit. Mus., ed. II, 1882, p. 44.
Rana flaviventris Millet, Faun. Maine et Loire, II, p. 663.
Rana cruenta Pallas, Zoogr. Ross. As., p. 12.
Rana alpina Risso, Hist. Nat. Eur. Mér., III, p. 93; Bonap., *l. c.*
Rana scotica Bell, *l. c.*, p. 102.
Rana platyrrhinus Steenstr., Amtl. Ber., 24, Vers. Kiel, p. 131.
Rana fusca De l'Isle, Ann. Sc. Nat., sér. 5, XVII, 1873; Leydig, An. Batr., p. 116; Boulenger, Bull. Soc. Zool. France, 1879, p. 164; Héron Royer, Bull. Ac. Belg. (3), I, No. 2, p. 139.
Rana temporaria var. *platyrrhina* Schreib., Herp. Eur., p. 125; Günth., Cat., p. 16; Rösel, Hist. Ran., p. 1, Pls. 1–8.
Rana dybowskii Günth., Ann. & Mag. N. H., 1876, XVII, p. 337.

Vomerine teeth in two small oblique groups, extending beyond the hinder edge of the choanæ. Head moderate; snout short, blunt; interorbital space as broad as the upper eyelid; tympanum distinct, two-thirds the diameter of the eye. Fingers moderate, first extending beyond second; toes at least two thirds webbed; subarticular tubercles of fingers and toes moderate; inner metatarsal tubercle small, obtuse; outer tubercle none or scarcely distinct. The hind limb being carried forward along the body, the tibiotarsal articulation reaches

hardly the tip of the snout. A moderately prominent glandular lateral fold. Upper parts grayish or brown, more or less spotted with dark brown or black; a more or less intense dark temporal spot; a light line from below the eye to the extremity of the temporal spot; sides of body largely spotted; limbs transversely barred; beneath more or less spotted. Male with two internal vocal sacs.

The above synonymy and description are taken from Boulenger, to whom we are indebted for the most complete studies of the European species of Rana.

The typical form of this species is distributed over northern and temperate Asia and Europe, but a subspecies is common in the western regions of North America. This has been called *Rana pretiosa* by Messrs. Baird and Girard. It differs from the Old World form as follows:

Head from three and five-tenths to four times in length; temporal spot more distinct; ..... *R. t. temporaria.*

Head from three to three and five-tenths times in length; temporal spot less distinct ..... *R. t. pretiosa.*

Rana temporaria pretiosa Bd. & Gird.*

Rana pretiosa Baird. & Girard. Proceed. Ac. Phila., 1853, p. 378; Baird, Proceed. Ac. Phila., 1855, p. 378; Girard. U. S. Expl. Exped., Herp., p. 20, Pl. 2, figs. 13-18; Cooper, U. S. Expl. Surv., XII., part II. p. 304; Boulenger, Bull Soc. Zool. Fr. 1880, p. 208; Cope, Proceed. Ac. Phila., 1883, pp. 20, 33; American Naturalist, 1879, p. 435.

The form is rather stout and the head is not so small as in the typical *R. temporaria.* The heel of the extended hind leg reaches to the posterior border of the orbit, or from that point to the anterior border. The inner cuneiform tubercle is small and obtuse, and there is a small external one. The following description is taken from a female:

Body stout, depressed, in shape much like *R. catesbiana.* Head obtuse, rounded, and subtruncate. Head broader than long. Canthus rostralis not distinct. External nostrils small, circular, nearer the snout than the eyes; a shallow groove behind them with a minute papilla, as in most frogs. Head flat between the eyes; sides oblique; facial excavation very shallow. Eyes small, contained a little more than three times in the chord of the commissure and three and one-half in that of the lower jaw, one and one-half diameters from the tip. Tympanum very small (in small specimens quite indistinct), scarcely two-thirds the size of the eye, and distant from it by nearly a diameter. Tongue very large and fleshy, free behind for half its length. Inner nares narrow, elongated in one specimen to a mere slit. Vomerine teeth in two small oblique patches, approaching behind, but separated by an interval equal to that between the anterior extremity and the inner nares. This anterior extremity is on a line with or rather posterior to the hinder border of the inner nares.

Skin everywhere thick and leathery, minutely pitted; on the sides and posterior part of the body with external surfaces of hind legs, pus-

* Plate 49, fig. 12.

tulated with small asperities, seen even on the interior digital membrane. Those on the buttocks seem to replace the usual granulation, of which no traces are visible. Many of these latter pustules on the buttocks appear to consist of glands, as their open mouths are visible in the largest specimen on the inferior surface.

The third finger is longest, then the fourth; the first longer than the second. The femur is shorter than the tibia, and both shorter than the foot; they are not quite half the length of the body. The fifth and third toes are equal; the foot well webbed. The terminal joint of the fourth toe is entirely free; the web extends from the tip of the outer toe to nearly the second articulation of the next, running up to the first articulation, and again on the other side in a similar manner, narrowing to the tips of the third, second, and first toes on the exterior sides, and on the inner, starting from the first articulation. The inner edge of the foot is narrowly margined. The cuneiform process is elongated and diminutive, with a small tubercle opposite it on the sole, the whole of which is covered by asperities. Inner toe not one-third total length of foot.

There is a broad depressed ridge extending from the eye on each side nearly to the flanks, becoming indistinct posteriorly; in some specimens perceptible at any point. No other ridges are visible, except a slight glandiform prolongation of the upper jaw, extending over the arm, and interrupted opposite the end of the jaw and above the shoulder by the groove passing behind the tympanum.

General color, above dull yellowish-brown (dead leaf), darker on the sides. A number of circular brown blotches on the back between the ridges, which themselves are rather brighter than the rest of the ground-color, and not invaded by the blotches. In some these blotches are very few in number, and in none are they in any definite serial arrangements or areolated. The outer surfaces of the limbs are blotched transversely; a dull yellowish line along the upper jaw, distinct only under the eye, narrowing behind, and terminating above the arm; in young specimens an indication of a dark area back of the eyes and including the tympanum, somewhat as in *R. sylvatica*. Under parts yellowish-white, obsoletely marbled with brown. In life the groin and posterior parts of the abdomen, with the adjacent parts of the thighs, are salmon-color. I took a specimen at Salt Lake City, Utah, which has no trace of dermal folds, and a smooth skin. Sides and above uniform dusky; thighs below and posterior part of abdomen red.

This is the characteristic Rana of the northwestern interior, being accompanied by *Bufo columbiensis* and *Bascanium vetustum*. In life the posterior part of the abdomen, with the inferior faces of the thighs, are of a bright salmon red. I obtained it the entire length of the valley of the Warner Lakes, but not at Fort Bidwell. I have found it to range as far as the eastern foot of the Rocky Mountains in Montana;* and

*American Naturalist, 1879, p. 435.

the specimens assigned by me * to *Rana septentrionalis*, from the Yellowstone Basin, may be the variety described above from Salt Lake City. I do not now have them before me for decision.

The habits of the *Rana pretiosa* are entirely aquatic.

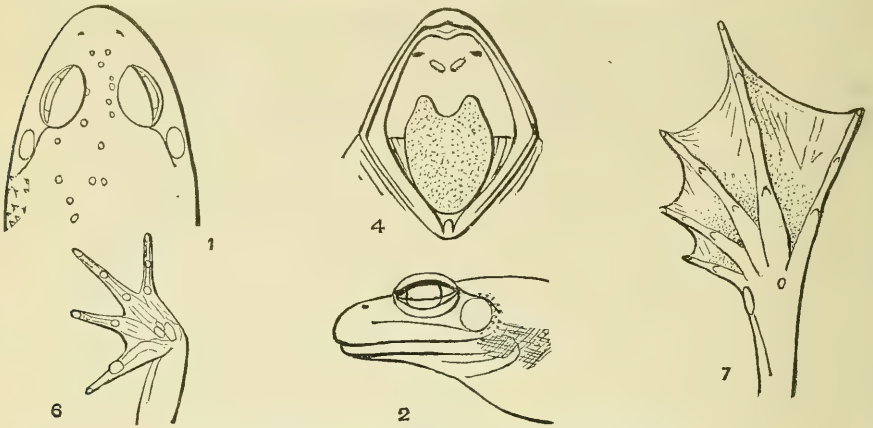


FIG. 110. *Rana temporaria pretiosa*. No. 5973. Oregon; ½.

Female.

	Inches.			Inches.	
Total length	2.74	1.00	Inner toe from tarsus	.54	.19
Fore-arm from shoulder	1.46	.53	Hind leg	4.46	1.63
From elbow	1.18	.43	Chord of jaw	.91	.33
Femur	1.24	.45	Width of head	.92	.33
Tibia	1.32	.48	Length of eye	.26	.09
Tarsus	.72	.26	Tympanum	.18	.07
Hind foot	1.52	.55			

Rana temporaria pretiosa Baird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
5973	1	Camp Morgie, Oregon		C. B. Kennerly	Alcoholic.
8683	7	Southern California	1875	H. W. Henshaw	Do.
8687	4	Nevada	Oct. —, 1875	do	Do.
11409	4	Puget Sound, Oregon		U. S. Expl. Exped	Do.
8685	3	Lake Tahoe, Nevada	Oct. —, 1876	H. W. Henshaw	Do.
3437	2	Red River of North		R. Kennicott	Do.
3360	1	Klamath Lake, Oregon		Dr. C. G. Newberry	Do.
3366	1	(?)		Dr. A. L. Heerman	Do.
8679	1	Santa Barbara, Cal	1875	H. W. Henshaw	Do.
9401	2	Puget Sound, Oregon		Dr. C. B. R. Kennerly	Do.
4824	1	St. Catherine's, Canada		Dr. D. W. Beadle	Do.
3378	1	North of River Nitz, Oregon.		Dr. George Suckley	Do.
11937	1	Upper Firehole Basin, Yellowstone Park.		C. Hart Merriam	Do.
11503		Fort Ellis, Mont	1872	W. B. Platt	Do.
11939	1 6	Upper Firehole Basin, Yellowstone Park.		C. Hart Merriam	Do.
11513	5	Des Chutes River, Oreg	1872	H. W. Henshaw	Do.
11521	4	Crooked River, Oreg	1878	do	Do.
11531	1	Mountains near Fort Klamath, Oreg.	1878	do	Do.
14498	5	Fort Walla Walla, Wash.	1878	Capt. Charles Bendire, U. S. Army.	Do.
10919	4	do	1881	do	Do.
10921	2	do	1881	do	Do.
10923	10	do	1881	do	Do.
10924	11	do	1881	do	Do.
10925	2	do	1881	do	Do.
14499	1	California		Dr. J. G. Cooper	Do.

* Annual Report U. S. Geol. Survey Terrs., 1871, p. 469.

RANA CANTABRIGENSIS Baird.

Proceed. Ac. Phila., 1854, p. 62; Boulenger, Bull. Soc. Zool. France, 1880, p. 209; do. Cat. Batr. Sal. Brit. Mus., 1882, p. 45.

Rana sylvatica De Kay, N. Y. Faun, III, p. 64, Pl. 21, 22; Boulenger, Bull. Soc. Zool. France, 1879, p. 174.
Rana temporaria, var. *silvatica* pt., Günth., Cat. Brit. Mus., 1868, p. 17.
Rana temporaria cantabrigensis Cope, Check-List N. Amer. Batr. Reptil., 1875, p. 32.

This species differs more widely from the *R. temporaria* than does the *R. pretiosa*, so much so, that I now follow Professor Baird and Mr. Boulenger in maintaining it as a distinct species. As usual with the species of their genus, it presents such variations as to render the common origin of all these forms certain. Thus in four specimens from Lake Alloknagik, Alaska, the web of the hind foot is as fully developed in the *R. temporaria pretiosa*, only two phalanges of the fourth toe being free. Associated with them was a specimen of the variety *R. cantabrigensis evittata*. In the specimen (No. 5169) from Puget Sound, Washington, the posterior leg is remarkably elongate, reaching the end of the muzzle, so as to approach nearly to the *R. silvatica*.

Two distinct subspecies and a variety of the *Rana cantabrigensis* are known to me, which differ as follows:

Only two phalanges free; no longitudinal stripes on back or tibia....*R. c. latiremis.*
Three phalanges free; no longitudinal strips on back or on tibia.....*R. c. evittata.*
Three phalanges free; a median dorsal and an anterior tibial light stripe .....*R. c. cantabridgensis.*

Rana cantabrigensis latiremis Cope.

Proceedings American Philos. Society, 1886, p. 520.

Muzzle rather obtuse, more so than in the typical *R. cantabridgensis*, and widened posteriorly; its length at the posterior edges of the tympana entering the length of the head and body three and a half times. The tympanic drum is very distinct, and its long diameter enters that of the eye two-thirds of a time. The nostrils are equidistant between the orbit and the end of the muzzle, and look upwards. The skin is quite smooth everywhere, with a dosolateral fold which is easily obliterated by immersion in alcohol. The heel of the extended hind leg reaches to the middle of the eye; the second toe reaches nearly to the apex of the knee. The palmation is remarkably wide, leaving but one free phalange on all the digits except the fourth, where two are free. The internal cuneiform tubercle is quite prominent, with an obtuse convex edge. There is no external tubercle. The internal finger (index) is short and stout, and is very little or not at all longer than the second (third) finger.

Color above, light brownish-gray; below, white. There are more or less numerous black spots on the sides, which incline to fuse more or less imperfectly into a longitudinal band along the dorsolateral dermal

fold. There are in some specimens a few small black marks on the back between the lateral folds. A dark line along the canthus rostralis. The black "ear-patch" is reduced to a black line, which passes from the eye over and posterior to the tympanic disk, and ceases opposite the inferior border of the latter.

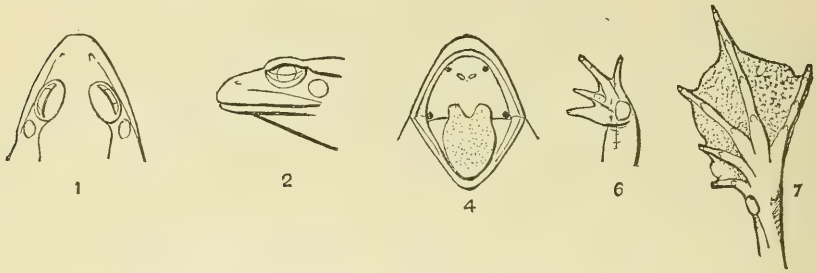


FIG. 111. *Rana cantabrigensis latiremis.* No. 13723, Alaska; ½.

Measurements of No. 13723.

	M.
Length of head and body	.052
Width of head at posterior edge of tympana	.019
Length of head to posterior edge of tympana	.015
Length of fore limb	.022
Length of fore foot	.011
Length of hind limb to groin	.071
Length of tibia	.020
Length of tarsus	.012
Length of remainder of foot	.025

Rana cantabrigensis latiremis.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
13723	1	Lake Alloknagik, Alaska.	——, 1882	C. L. McKay	Alcoholic.
13724	1	do	do	do	Do.
13725	1	do	do	do	Do.
13726	1	do	do	do	Do.

Rana cantabrigensis cantabrigensis Baird.*

Muzzle flat and rather acuminate, giving the head a tapering appearance, its length entering that of the head and body three and a half times. Tympanum half the diameter of the eye. Nostril equidistant between orbit and end of muzzle. A dorsolateral glandular dermal fold; the skin between them smooth, on the sides sparsely tubercular; first finger longer than second. Heel to middle of orbit; a glandular rib on the inner edge of the tarsus; webs of toes short; inner cuneiform tubercle prominent and obtuse-edged; a minute external tubercle.

The coloration of the typical form is as follows:

General appearance of *R. sylvatica:* Above, yellowish-brown; a dark vitta through the eye, margined below by whitish; lateral fold of skin light colored, as is also a median dorsal line extending from the snout to the anus; a narrow light line along the posterior faces of the thigh

* Plate 51, fig. 13.

and leg; the sides are frequently black-spotted, sometimes only marbled with brown; the spots are sometimes fused into a line on the external side of the dorsolateral dermal fold; the femora and tibiæ are indistinctly cross-banded, the pale line on the latter always interrupting the bands; upper lip, dark-edged; lower lip, dark-edged, with light-colored interruptions; a brown band on front of humerus; throat and thorax marbled with light brown; posterior face of femur light brown, marbled with darker brown.

FIG. 110. *Rana cantabrigensis cantabrigensis*. No. 5925. Fort Simpson; ¾.

Measurements of No. 9383.

	M.
Length of head and body	.050
Width of head at posterior margins of tympana	.017
Length of head to posterior margins of tympana	.014
Length of fore limb	.024
Length of fore foot	.011
Length of hind limb to groin	.072
Length of tibia	.022
Length of tarsus	.012
Length of remainder of foot	.024

The form *evittata* is probably only a color variety, as it displays no peculiarity other than that of color, referred to in the analytical table given above. It is also found at several localities mingled with the typical form, though this is not always the case. Judging from the collection in the National Museum, it is as abundant as the typical variety.

Rana cantabrigensis cantabrigensis Baird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3457	4	Western Missouri		Dr. P. R. Hoy	Alcoholic.
3458	5	Lake Winibigoshish Minn.		B. F. Odell	Do.
5386	5	James Bay, B. America		C. Drexler	Do.
5924	6	Fort Resolution		R. Kennicott	Do.
5937	13	James Bay, B. America		C. Drexler	Do.
3456	5	Red River of North		R. Kennicott	Do.
5919	38	Fort Resolution		do	Do.
3454	17	North Red River		do	Do.
5145	2	do		do	Do.
5925	1	Fort Simpson		do	Do.
14496	1	Alaska		E. W. Nelson	Do.
14109	1	Clark County, Ill	Aug. 1879	H. G. Hodge	Lo.
14072	1	Southern Alaska	1885	Lieut. George M. Stoney, U. S. N.	Do.
9383	14	Lake Superior		R. Kennicott	Do.
9384	1	Athabasca R		(?)	Do.
11515	1	M. of Nelson R., Hudson's Bay.		Dr. Robert Bell	Do.
14497	4	Fort Yukon, Alaska	1879	L. M. Turner	Do.

Rana cantabrigensis evittata Cope.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
5365	2	Moose River, B. America		C. Drexler	Alcoholic.
9385	2	St. Catharine's, Canada		Dr. D. W. Beadle	Do.
5922	2	Moose Island, B. America		C. Drexler	Do.
5366	2	Moose River, B. America		do	Do.
5364	3	Welthy River		R. Kennicott	Do.
5929	1	British America		do	Do.
14495	1	Nulato River, Alaska		W. H. Dall	Do.
6505	1	Big Island, Great Slave Lake.		John Reid	Do.
5169	7	Puget Sound		U. S. Expl. Exped	Do.
13727	1	Lake Alloknagik, Alaska.	1882	C. L. McKay	Do.

RANA AGILIS Thomas.*

Rana temporaria Millet, Faune Maine et Loire, II, p. 664.

Rana agilis Thomas, Ann. Sc. Nat., sér. 4, IV. p. 365, Pl. 7; Fatio, Rev. Mag. Zool., sér. 2, XIV, p. 81, Pls. 6 and 7, and Vert. Suisse, III. p. 333; De l'Isle. Ann, Sci. Nat., sér. 5, XVII; De Betta, Faun. Ital., Rett. Auf. p. 65; Lataste, Herp. Gir. p. 233; Leydig, An. Batr., p. 143; Lessona, Atti Ac. Lincei, Mem. Cl. Sc.—fis. I, p. 1074, P l. III; Boulenger Bull. Soc. Zool. France, 1879, p. 183; Catal. Batr. Sal. Brit. Mus., ed. II, 1882, p. 46.

Rana temporaria var. *arvalis*, pt., Günth, Cat., p. 16.

Rana gracilis Fatio, Rev. Mag. Zool. sér. 2, XIV, p. 81.

Rana temporaria var. *agilis* Schreib, Herp. Eur., p. 125.

Vomerine teeth in two oblique oval groups, extending beyond the hinder edge of the choanæ. Head depressed; snout rather elongate, subacuminate; interorbital space narrower than the upper eyelid; tympanum very nearly as large as the eye; close to it. Fingers moderate, first extending beyond second; toes at least two-thirds webbed; subarticular tubercles of fingers and toes much developed; inner metatarsal tubercle rounded, blunt, rather strong; a small outer tubercle. A narrow glandular lateral fold. Above grayish-brown, dark-spotted; a very dark temporal spot; a light line on the lip from the tip of the snout to the extremity of the temporal spot; hind limbs regularly cross-barred; beneath immaculate. Male without vocal sacks. (Boulenger.) France, Switzerland, North Italy, Greece.

Like the *Rana temporaria*, this species has its representative on the western coast of North America, which differs from it in some minor characters. This form has been named *Rana aurora* by Baird and Girard, and I regard it as a subspecies of the *R. agilis*. The two forms differ only in coloration, as follows:

Black ear-patch well defined; dorsal spots distinct, comparatively large; hind limbs with distinct cross-bars ..... *R. a. agilis.*

Ear-patch not dark-colored nor well defined; dorsal spots usually minute, or wanting ing; cross-bars of hind limbs very indistinct ..... *R. a. aurora.*

* Plate 75, fig. 20.

Rana agilis aurora Bd. Gird.

Rana aurora. Bd. & Gird. Proceed. Ac. Nat. Sci., Phila.

Body depressed, elongated; limbs elongated and well developed; head broad, acute, rounded anteriorly; nostrils elongated, situated below the crest of the canthus rostralis, half-way below the eye and tip of snout; eye moderate, contained three times in the chord of the commissure, situated two-thirds of its diameter from the rictus; tympanum small, but little more than half the diameter of the eye. Inner nares rather elongated transversely. The vomerine teeth very few in each patch; the patches quite small, somewhat elliptical, and inclined backwards, where they are separated by an interval a little less than that between the anterior extremities and nares; these extremities are in a line with the centers of the nares, but the teeth are on the posterior margins; the protuberances are decidedly posterior to the nares. Tongue small, narrow. Eustachian openings large.

The skin is everywhere free from asperities, but not smooth, and on an attentive examination is seen to be minutely pitted all over, and with coarser indentation on the upper surfaces of the limbs, the sides of the face, and along the dorsal fold, which appears quite porous. The buttocks are much granulated, a character which appears to extend a little on the abdomen and sides. A broad depressed fold of skin extends from the eye to the hind legs. This is distinctly perforated or porous throughout its extent. There are no intermediate ridges; a glandular prolongation of upper jaw to the arm, interrupted at the posterior extremity of the jaw; limbs very slender and much elongated; hand longer than the fore-arm; fingers all long; third longest, fourth next in size, then first and second. Femur rather less and tibia more than half the length of the body; hind foot and tibia about equal; foot not very broad. Fourth toe much the longest, and with the last two joints entirely free, as are the terminal joints of all the toes. The third joint of the longest toe has a very slight margin, diminishing to the second articulation, and the inner sides of the third and second toes are scarcely, if at all, margined. Cuneiform process small, soft; no other tubercles on the sole, and scarcely any indications of any under the joints.

Color when living greenish-yellow above, with golden reflections, maculated with black; sides of abdomen and hind legs reddish-orange; beneath dull yellowish-green, maculated; digital membrane purplish-violet.

In alcohol.—Above yellowish-gray, brightest anteriorly. A few scattered indistinct blotches on the upper parts and sides and scattered black dots on the head, above the eyes, on the snout, and along the dorsal ridge. Beneath yellowish, with obsolete small blotches somewhat marmorated anteriorly. The mottling is visible on the inner faces

of limbs. Faint traces of two or three transverse fasciæ on the thigh and leg. An obscure indication of a dark area about the tympanum somewhat as in *R. sylvatica*, and an interrupted dark line from eye to nostril. The side of head anterior to the eye is yellowish or greenish-yellow, finely mottled, narrowing beneath the center of the eye into a somewhat distinct line, which passes backwards over the maxillary fold of skin. In large specimens this line is indistinct, and in none is it traceable anterior to the middle of the eye.

In small specimens from Columbia River, apparently belonging to this species, the triangular dark area behind the eye, including tympanum, is more distinct, and beneath it is a yellow line commencing below the eye and reaching back to anus. The buttocks are brown, with small light or gray-colored spots.

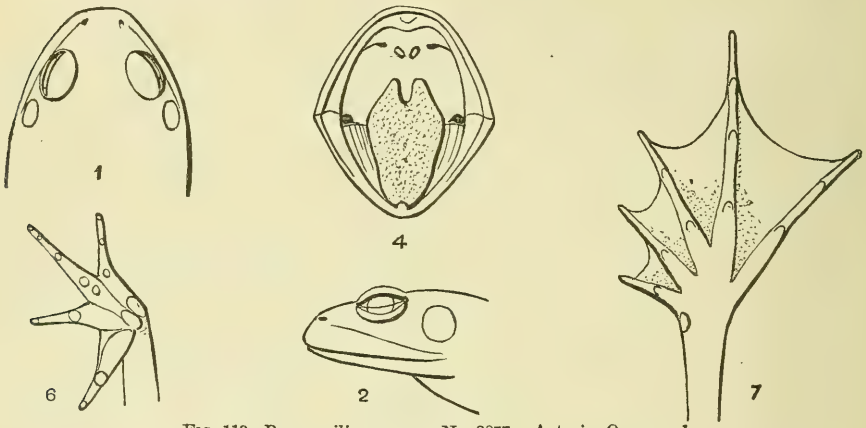


FIG. 113. *Rana agilis aurora*. No. 3877. Astoria, Oregon; ½.

	Inches.			Inches.	
Total	2.96	1.00	Foot	1.57	.53
Arm	1.90	.66	Shortest toe	.52	.17
Fore-arm	.66	.22	Leg	5.04	1.70
Hand	.76	.26	Chord of jaw	1.06	.36
Femur	1.44	.48	Width	1.03	.35
Tibia	1.54	.52	Eye	.32	.11
Tarsus	.84	.28	Tympanum	.22	.07

Rana agilis aurora Bd. Gird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3362	2	San Francisco, Cal		Major Le Conte	Alcoholic.
3371	8	Columbia River		U. S. Exploring Expedition.	Do.
9467	1	Puget Sound, Wash. Ter		Dr. C. B. R. Kennerly	Do.
3374	6	Petaluma, Cal		E. Samuels	Do.
9420	1	Puget Sound, Wash. Ter		Dr. C. B. R. Kennerly	Do.
9421	1	do		do	Do.
3345	4	Shoalwater Bay, Wash		Dr. J. G. Cooper	Do.
3377	2	Astoria, Oregon		Lieut. W. P. Trowbridge, U. S. Army.	Do.
11711	4	Puget Sound, Wash		U. S. Exploring Expedition.	Alcoholic types.
3369	1	Monterey, Cal		A. S. Taylor	Alcoholic.
2628	1	Fort Umpqua, Oregon		Dr. Vollum	Do.

RANA DRAYTONI Bd. & Gird.

Rana draytoni Bd. & Gird., Proceed. Ac. Phila. (1862), p. 174; Girard, U. S. Expl. Expedi., Herp., p. 23, Pl. II, figs. 19–24.

Rana lecontei Bd. & Gird., Proceed. Ac. Phila. (1853), p. 301, Günth., Cat., p. 15; Brocchi, Bull. Soc. Philom., (F.) I, p. 179, and Miss. Sc. Mex., Batr., p. 14, Pl. IV, f. 1.

Rana nigricans, Hallow., Proceed. Ac. Phila. (1854), p. 96; Boulenger, Bull. Soc. Zool. Fr. (1880), p. 207; Brocchi, Miss. Sc. Mex., Batr., p. 15, Pl. IV, fig. 3.

Rana longipes, Hallow., U. S. Expl. Surv., X (1859), IV Zool., p. 20, Pl. X, fig. 1.

Epirhexis longipes Yarrow, Check List and Catal. of Spec. of N. Amer. Reptiles, Batr., (1883), p. 176. Not of Baird & Cope.

Sp. ch.—Body stout. Head broader than long. Eye large; contained two and a half times in chord of jaw, and distant one-half time its diameter from the rictus. Tympanum three-fourths length of eye-fissure. Body with tubercles above, each with a pore; without decided asperities. A glandular fold along upper jaw and a broad depressed ridge on each side of back. Femur and tibia nearly equal, about half the length of body, shorter than hind foot. Hind foot well webbed; terminal joints free, as are second joints of second, third, and fourth toes on inner edges. Above yellowish-olive, with blotches of darker, interpersed with dark dots. Inferior and inner surfaces greenish-white, everywhere obsoletely blotched finely with darker.

There are two subspecies of the *Rana draytoni*, which inhabit different zoological subregions. They differ as follows:

Hind foot two and a half times the length of the head; skin above tubercular; a dark ear-patch; larger.....*R. d. draytoni.*

Hind foot twice length of head; skin above smooth; no dark ear-patch; size smaller.....*R. d. onca.*

Rana draytoni draytoni Bd. & Gird.*

Body stout and heavy. Limbs massive and well developed. Head rather broader than long. Nostrils moderate, with the usual papilla behind, situated nearer the snout than the eye. A triangular excavation in front of eye, extended backwards under the eye. Eye large, contained two and one-half times in chord of commissure, one-half of its diameter from rictus. Tympanum small, indistinct, transversely elongated; rather more than half the length of eye (its shortest diameter about equal to half this length). A glandular fold or ridge on the backward prolongation of the jaw, interrupted at rictus. Inner nostrils elliptical. Vomerine teeth in two series, obtuse-angled behind, where they are separated by an interval less than their distance anteriorly from nostrils, the ridges ranging with the centers of the nares, and the teeth on a line with their posterior margin. Tongue not large.

Skin thick and leathery (apparently the case in most frogs from the Pacific coast); above it is uniformly covered with depressed and softened tubercles, each tubercle with a distinct pore, sometimes with a

* Plate 51, fig. 11.

smaller one in it, especially on the back. Fore legs slightly tubercular only. Buttocks granulated; the granules depressed (not tubercular). On each side a broad depressed ridge of skin, not very distinct at first sight, extending from the eye over tympanum in a line slightly convex above to near the groin, where it is interrupted, and then takes a sudden bend upwards, over the leg, towards the anus, ceasing about opposite the articulation. This ridge is sometimes only traceable by the cribriform pores, which are crowded in it for its whole length; no branch visible back of the tympanum. A glandular fold, as already described, back from the jaw. Tibia about half the length of the body; a little, longer than the femur and shorter than hind foot; third finger longest; then fourth; second rather shortest; first much swollen at the base. Terminal joints of toes nearly free from web, especially on the inner edge, which is the case with the inner edges of the second joints of the second, third, and fourth toes. The membrane extends along the outer edge of second joint of fourth toe for a short distance. Cuneiform process moderate, with a small tubercle opposite it on the sole. Rounded tubercles beneath all the articulations, except the terminal. Tips of all the fingers and toes somewhat knobbed.

Color above yellowish-olive, with obsolete subcircular indistinct blotches of darker, interspersed with dark dots of the same, generally on the tubercles. The dots appear somewhat condensed along the dorsal ridge. A few indistinct transverse fasciæ on the legs. Beneath, greenish-white, with indistinct mottlings of dusky present on the inner faces of the limbs, leaving no portion of the body unicolor. A trace, perhaps, of a yellowish line along the posterior portion of the jaw. Buttocks dark brown, with light spots.

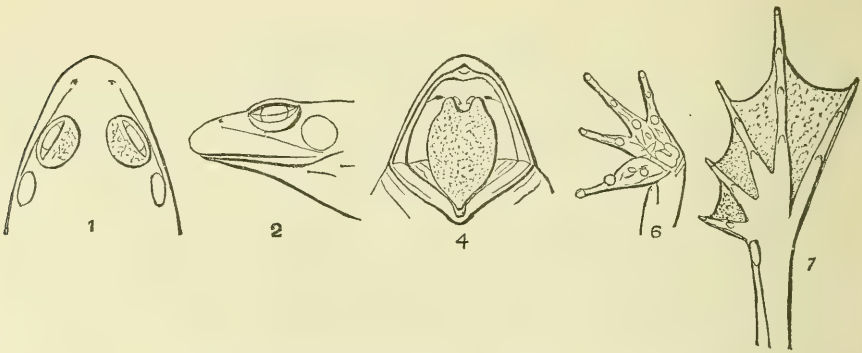


FIG. 114. *Rana dragtoni draytoni*. No. 8700. California; ½.

With a general resemblance to *R. aurora*, it differs in being more tubercular and pustulous above, the shorter limbs, the smaller but more fully webbed feet, broader head and tongue, etc.

This species differs from *R. clamata* in the broader, more depressed body, and dorsal fold, large foot, smaller tympanum, etc.

Measurements of male.

	Inches.			Inches.	
Total length	3.24	1.00	Hind foot	1.82	.56
Fore leg	2.63	.75	Inner toe	.60	.18
Fore-arm	.62	.19	Hind leg	5.62	1.73
Hand	.80	.25	Chord of upper jaw	1.10	.34
Femur	1.64	.50	Width	1.16	.36
Tibia	1.66	.51	Eye	.40	.12
Tarsus	.86	.26	Tympanum (long diam.)	.26	.08

At the time when the description of *R. lecontei* was prepared the limits of variation of the species were not as well understood as they have since become from an examination of many specimens from different localities. On this account the species was established on specimens of small size, collected by Dr. Le Conte, but which I consider to belong to the *R. draytoni*. The color above is a dark olive-brown, with numerous uniformly distributed darker and well-defined circular blotches about the size of the pupil, and most of them with a rather lighter center. They are principally embraced within the lateral ridges, though some are exterior to them. The buttocks are dark brown, with well-defined spots and dots of yellowish, smallest near the anus. The transverse bars on the legs are numerous, narrow, and well-defined, three to five on the tibia. A narrow and well-defined greenish-white line along the upper jaw from beneath the eye, and a lighter tinge along the lateral ridge. Beneath yellowish, marbled with brown on the whole under and inner surfaces.

Rana draytoni Baird & Girard.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3374	5	Petaluma, Cal		Dr. E. Samuels	Alcoholic.
9420	1	Puget Sound		Dr. C. B. R. Kennerly	Do.
3376	1	California		A. L. Heerman	Do.
3370	2	El Dorado, Cal		Dr. Boyle	Do.
11497	6	San Francisco, Cal		United States Exploring Expedition.	Do.
354	1	Presidio, Cal		Lieut. W. P. Trowbridge	Do.
8700	1	Mountains near Fort Tejon, Cal.		H. W. Henshaw	Do.
	4	California		Dr. J. L. Leconte	

Rana draytoni onca Cope.

Yarrow's Rep. Expl. Surv. W. of 100th Mer., Zoology, vol. v, p. 528, Pl. 25, figs. 1–3.

Head oval; muzzle sloping to the lip. Diameter of tympanic membrane equal distance between nares and between nostril and orbit, and three-fourths the diameter of the orbit, or the distance from nares to margin of lip in front. Vomerine teeth in fasciculi behind the line connecting the posterior borders of the choanæ. A dermal fold on each side of the back, and a short one behind the angle of the mouth, with

some scattered warts on the sides; skin otherwise entirely smooth. Toes obtuse, with wide webs reaching to the base of the penultimate phalange. One long metatarsal tubercle; one fold on the tarsus; a dermal border on outer toe. The heel extends beyond the end of the muzzle.

Light brown above; below, yellow. Three rows of rather distant, solid, small black spots between the dorsal folds; two or three rows on each side; none of the spots yellow-bordered. Head unspotted; no band on the lip. A brown vertical band on the front of the humerus. Scattered spots on tibia and femur; clouded spots on the posterior face of the femur. Size of *Rana clamata*.

This frog, of which a female specimen was obtained, combines characteristics of different groups; its coloration resembles somewhat that of the eastern or typical form of *Rana virescens*, but the full palmation of the hind foot is that of *R. montezumæ* and *R. catesbiana*. It is also quite similar to the *R. draytoni*, which is the *R. longipes* of Hallowell. The feet are shorter, the hind feet being twice as long as the head to the posterior border of the tympanum, while in *R. d. draytoni* it is two and five-tenths times as long. The *R. onca* lacks the black cheek-patch of the *R. d. draytoni*.

Utah, 1872; Dr. H. C. Yarrow; alcoholic; female.

RANA BOYLII Baird.

Proceed. Ac. Phila., 1855, p. 62.

Rana pachyderma Cope, Proceed. Ac. Phila., 1883, p. 25.

Tympanum small, very indistinct. A broad depressed ridge of skin on each side of back. Skin finely tubercular above. Head broader than long. Tibia and femur more than half the length of body; the latter the longer. Hind foot less than half this length; webbed entirely to the expanded tips; outer toe decidedly longer than the third. An elongated tubercle at base of inner toe, with another opposite it. Above dull reddish-olivaceous, with indistinct blotches and dark spots on the back and fasciæ on the legs. Beneath yellowish, mottled anteriorly. Inner faces of legs immaculate.

Body rather stout. Limbs well developed. Tibia and femur very long. Head short, broad; outline rounded, although the tip is rather acute. Nostrils small, situated on the crest of the decided canthus rostralis about midway between the eye and the tip of the snout. Eyes large, situated far back; contained three times in the chord of the jaw and one and a half diameters from the tip of snout; less than half a diameter from the rictus. A moderate excavation in front of the eye. Tympanum very small and indistinct, not half the diameter of the eye, covered with the small tubercles of the skin. A slight fold of skin above it and proceeding toward the arm, met by an indistinct thickening of the skin from the jaw, as in the typical species. Tongue

large, fleshy, with a rounded notch behind, leaving the posterior cornua as two short obtuse processes, differing from the cornua of the typical *Rana;* the tongue free posteriorly for half its length. Internal nares small, distant, elongated transversely. Vomero-palatine teeth in two longitudinal series, approaching each other obtusely behind, and separated by a considerable interval; anteriorly these teeth (of which there are only three or four in the lineal series) do no quite reach the level of the inner nares.

The skin is thick and coarse, above finely uneven; smooth and even below. Above and on sides thickly sprinkled with minute tubercles, even on tympanum. A broad, depressed, scarcely distinguishable ridge from the eye along the sides, indicated in the shrunken specimen more by a peculiar pitted appearance than in any other way. On the sides are several circular areas of moderate size marked in the same way, probably large pustulations in life. The anteroinferior face of buttocks with distinct porous pits; the posterior faces granulated. The arms are well developed; the fore-arm and hand about equal; the third finger longest; the inner very much swollen at the base, which is dark and horn-like. Femur considerably more than half the length of body and longer than the hind foot; the tibia still longer. The feet are broad; each toe slightly dilated at the rounded tip, with epidermis thickened and horn-like; the fourth toe is longest; the outer considerably longer than the third. The web extends completely between all the tips, so that there is nothing free but the very extremities. There is an elongated unarmed tubercle at the base of the inner toe, and a smaller one opposite to it; well-developed tubercles are seen under all the articulations. The transverse apophyses of the sacral vertebra not dilated.

Above dark reddish or yellowish-olive, very obscurely mottled with darker, and a faint indication of yellowish along the region of the lateral ridge. Some whitish spots on the sides, and scattered black dots above on the tubercles. Legs transversely and obsoletely banded with darker. Beneath yellowish, with obscure mottling on the throat. No trace of a light line on the jaws, which are mottled.

A tadpole of this species measured three-fourths of an inch to the anus, and two inches to the tip of the tail, and yet the fore legs had not been protruded, although fully formed, showing a considerable growth before maturity.

The specimen above described is from El Dorado County, Cal., and was for a long time the only one in our collections. During my expedition to Oregon in 1879 I rediscovered it, and found it rather abundant in the mountainous regions of northern California. The following is a description of a specimen from Baird, on the McCloud River, one of the heads of the Sacramento.

This species belongs to the *Rana temporaria* group, and must be compared with *Rana agilis aurora* Bd. Gird., and *R. temporaria pretiosa* Baird

and Girard. The vomerine teeth are opposite the posterior border of the choanæ, and form two short, oblique series, directed inwards and backwards. The toes are webbed to the terminal phalange of the fourth digit. The hind leg extended reaches the extremity of the muzzle with the heel. There are two plantar tubercles. The internal is narrow, rather prominent, and with obtuse extremity; the other is at the base of the fourth metatarsal bone, and is rounded.

The muzzle is obtuse and the head rather wide. Its greatest width at the position of the membranum tympani equals the length from the end of the muzzle to the line connecting the axillæ in some specimens; in others to that connecting the middle of the humeri. The skin is on all the superior surfaces thick and glandular. This condition is especially marked in the dorsolateral fold of each side, which is so thickened in front as to resemble a paratoid gland. This becomes less visible in alcohol. The tympanic membrane is either entirely concealed or is represented by a depression only. The skin covering it is roughened. A groove extends downwards and backwards from it. Between this and the canthus ovis is a glandular thickening, and behind it are two others, one above the other. Posterior to these, on the sides, is a succession of rounded, roughened warts, similar to those on the toads. Similar warts, but less prominent, are scattered over the dorsal region, and are numerous near the extremity of the coccyx. The skin of the superior surfaces of the head, body, and limbs is minutely but very distinctly roughened by small warts, each of which gives exit to a pore. Inferior surfaces smooth. Length of fingers, beginning with the shortest, 1, 2, 4, 3.

The color is dark brown or nearly black, with indistinct darker spots on the back; sides brown. Axilla and groin yellow, marbled with black. Thighs above light or dark brown, with three darker cross-bars. Tibiæ similar, with three cross-bars. Thighs, behind, black, coarsely vermiculated with yellow, or yellow closely spotted with black; below, light yellow, spotted with brown on the gular region and on front of femora.

The specimens from Ashland agree with those from the McCloud, except that they are nearly black above and do not exhibit the dorsal spots.

I compare this species with the *Rana draytoni*, from the Russian River, near the coast of California. That species has but one palmar tubercle, the internal, which is of similar proportions to that of the *R. boylii*. The skin is not thickened, and is much less glandular everywhere. The membranum tympani is entirely distinct. The posterior face of the femur is not vermiculated with yellow, but is covered with large black masses. The whole of the under surfaces are brown-spotted. There are four brown cross bars on the tibia; traces of the fourth sometimes appear in the *R. boylii*. From *Rana pretiosa* it differs in all these characters, besides those that belong to the latter; *i. e.*, the fasciculated vomerine teeth and the short hind legs.

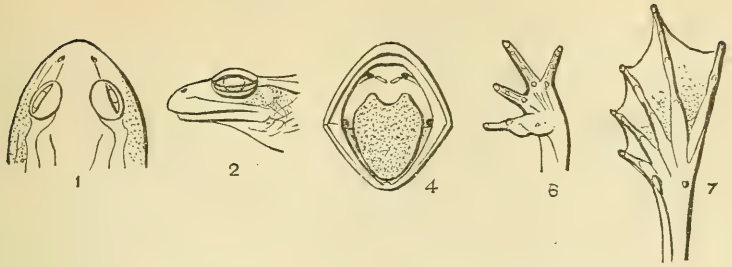


FIG. 115. *Rana boylii.* No. 3370. Natural size. El Dorado, Cal.

Measurements of No. 3370.

	M.
Length of head and body	.045
Length of head to line connecting canthus ovis	.0132
Width of head at line connecting canthus ovis	.019
Length of muzzle to line of anterior canthus ocularum	.062
Length of fore leg	.0275
Length of foot	.014
Length of hind leg	.0753
Length of hind foot	.034
Length of hind foot without astragalus	.023

Rana boylii Bd. & Gird.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3370	2	El Dorado, Cal		Dr. D. C. Boyle	Alc. type, ♂.
13929	12	Baird, Shasta County, Cal.		C. H. Townsend	Alc.

In addition to the above, I obtained five specimens from Baird, and two from Ashland, Oregon, at the northern base of the Siskiyou Mountains, which form the boundary between Oregon and California.

RANA SILVATICA Lec.

Rana sylvatica Le C., Ann. N. Y. Lyc., I (1825), 282; Harlan, Sillim. Amer. Journ. Sci., X, (1825), 58; 1 b. Journ. Ac. Nat. Sci. Phila., V (1825), 338; 1 b. Med. and Phys. Res. (1835), 103, 221; Holbr., N. Amer. Herp., 1st ed., I (1836), 95; 1 b., 2d ed., IV, (1842), 99, XXIV; Storer, Rept. Mass. Reptil. (1839), 239; Dum. & Bibr., VIII (1841), 362; De Kay, N. Y. Zool., III (1842), 64, XXI, fig. 54, and XX, 50; Thompson, Nat. Hist. Vt. (1842), 121; Weid., Nova Acta Ac. Leop., XXXVII, 114; De l'Isle, Ann. Sci. Nat., sér. 5, XVII; Boulenger Catal. Batr. Sal. Brit. Mus., 1882, p. 47.

Rana pennsylvanica Harlan, Sillim. Amer. Journ. Sci., X (1825), 58; Boulenger, Bull. Soc. Zool. France, (1879), 188.

Body rather broad and much depressed; angulated by the lateral radies; the widest portion just anterior to the fore legs. Limbs long and slender.

Head pointed, broad; the sides obliquely sloping; eyes not visible from beneath; distance between the anterior canthi about two-fifths that

between the rami. Loral space rather excavated or concave. Nostrils moderate, rather oblique; situated below the canthus rostralis, so as to be fully visible beneath the outline of the profile; they are situated half-way between the anterior canthus of the eye and the tip of the snout, and not so far forward as the tip of the lower jaw; they are separated by about the diameter of the eye, or one-fourth the distance between the rami. Eyes large, projecting, their centers nearer the hinge of the jaws than the end of snout, the posterior margins above the rictus. Tympanum moderate, its posterior edge on a line with the posterior end of jaws, its center raised, its longest diameter vertical, and about two-thirds that of the eye. The light line under the eye is prolonged into a thickened glandular fold of skin which is interrupted abruptly above the insertion of the arm; the middle of the interval between this interruption and the end of the snout opposite the center of the eye. The distance between the rami rather less than to the end of snout. Upper jaw projecting moderately.

The tongue is elongated, much longer than broad, free behind for more than half its length and on the sides to the tip; the two cornua moderately prominent. Internal nares moderate, circular, and nearer the anterior canthus of the eye than to the external nostrils. Teeth in two small slightly elongated patches, placed with their axes a little inclining backwards and about intermediate between the nares, their anterior edges being in the same line. They are about as far apart behind as their anterior edges are from the nares on either side. The teeth of the upper jaw extend back to the gape of the mouth.

The skin of the upper and exposed portions of body and limbs is more or less roughened by minute and close-pressed tubercles, with here and there a larger interspersed. These do not appear to be at all glandular or excretive. They are largest and most prominent on the sides and the posterior portion of the back, where they are generally black. The posterior and inferior face of the thighs is granulated for about two-thirds its length, as well as a small portion of the belly on the pubic region. The sides are scarcely granulated, although coarsely pustulate; all the rest of the lower parts of body, including the concealed surface, are perfectly smooth. The skin of the thigh is pierced by innumerable fine pores.

As already stated, there is a fold of skin as a continuation of the light stripe along the edge of the upper jaw, and extending to a point just above the middle of the arm, thickened behind. A rounded depressed ridge or fold of skin commences at the posterior end of the eyelid, and, curving a little downwards to the tympanum, sends off a short branch along its posterior border, then continues along the sides of the body (over the extremities of the transverse processes of the vertebra), ceasing at the insertion of the hind leg.

The fore-legs are well developed; the fore-arm shorter than the hand. All the fingers are perfectly free. The third finger is longest, the first

and fourth equal, the second least. All are thickened at base and tapering to tips, and have a bulb under each joint and several on the palm. There is considerable power of opposition in the inner fingers. The tibia and femur are considerably more than half the length of the body. The former is longer than the foot; the femur intermediate. The fourth toe longest; the third rather longer than the fifth, and extending to the middle of third phalange (from tip) of longest; the second and first successively shorter. All the metatarsals are separated by about half their distal extremities and the interval filled by membrane. The web extends from the first joint (from tip) of the outer toe to the second of the fourth; from this same joint to the first of the third toe; from the second joint of the third to the first of the second; from the second of the second (extending by a very narrow web to the first) to the first of the first; the outlines, when stretched, very concave, elongated, and rather sharp. The terminal phalanges of all the toes and the last two of the longest are thus free. The cuneiform process is well developed.

Upper parts a yellowish-gray, tinged with brown on the sides. The side of the head below the canthus rostralis and lateral fold, including tympanum, is of a dark reddish-brown (sometimes black), extending in an acute angle to a termination just above the insertion of the arm or posterior edge of the maxillary fold. Edges of both jaws dark brown, a little mottled. A yellowish-white line from the tip of the snout parallel with the margin of the upper jaw, and, running over the maxillary fold, terminates with it. All the lower and interior faces of the body are yellowish-white, with an obscure mottling of brown on the throat. A few scattered spots of black on the sides and the posterior portion of the back, principally on the larger tubercles. There are three or four transverse dark bars across the faces of the thighs; the posterior faces are mottled with obscure brown, on a yellowish ground; the brown aggregated into a ring around the anus. The inferior surfaces of the tarsus and fore-arm dark brown; an elongated brown spot at the proximal extremity of the arm, extending obliquely from the lower jaw.

Some specimens from Racine have the body rather stouter and the legs shorter, the web of hind feet rather more developed. A number of faint white spots on the posterior face of the buttocks. Others from the same locality, however, have the characters as given above. Occasionally the membrane of the foot does not extend beyond the third joint (from tip) of the longest toe, and in the typical specimen from Carlisle it only reaches to the second joint by a narrow margin.

A specimen from Quebec is rather darker than usual, especially on the sides, and has the feet webbed more than is described above.

A female specimen from Westport, N. Y., is stouter and the head broader than in a male. The legs are rather shorter. There is less granulation on the pubis, while the granules on the posteroinferior

surface of the thighs are more depressed, larger, and more separated than usual by the intermediate valleys. No appreciable difference in the size of the tympanum.

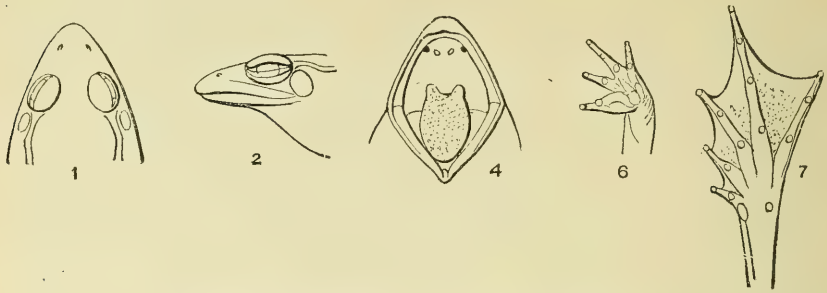


FIG. 115. *Rana silvatica*. No. 3388. Quebec, D. C.; ½.

Measurements.

	Inches.			Inches.	
Total (body straightened)	1.95	1.00	Leg	1.10	.56
Fore-arm	.33	.17	Tarsus	.56	.29
Hand	.50	.25	Foot	1.00	.51
Between tips of extended arms	3.10	1.59	Total hind leg	3.66	1.88
Thigh	1.10	.56	Width of head	.33	.65
			Chord of ramus	.34	.67

Rana silvatica Le Conte.

Catalogue number.	No. of spec.	Locality.	When collected.	From whom received.	Nature of specimen.
3393	4	Westport, N. Y		Prof. S. F. Baird	Alcoholic.
3388	1	Quebec, Canada		do	Do.
3397	1	Anderson, S. C		Miss G. Paine	Do.
3385	1	Racine, Wis		Dr. P. R. Hoy	Do.
3392	1	Clarke County, Va		R. Kennicott	Do.
3399	1	Carlisle, Pa		Prof. S. F. Baird	Do.
3398	3	Yellow Creek, Ohio		do	Do.
5452	1	Toledo, Ohio		J. B. Trembley	Do.
3390	1	Carlisle, Pa		Prof. S. F. Baird	Do.
3384	1	do		do	Larvæ.
3387	1	do		do	Alcoholic.
9387	1	Upper Wisconsin River		R. Kennicott	Do.
5447	3	Lake Superior		Barnabus	Do.
8377	1	Scarborough, Me		U. S. Fish Commission	Do.
5281	1	Selkirk Settlement			Do.
9384	1	Athabasca River			Do.
7836	1	Washington, D. C		Dr. E. Coues, U. S. Army	Do.
3735	1	Ogdensburgh, N. Y			Do.
5417	2	Illinois		R. Kennicott	Do.
5922	1	Moose River, British America.		C. Drexler	Do.
9668	1	Prince George's County, Md.	May—, 1878	Dr. T. H. Bean	Do.
8928	1	Kinston, N. C		Jas. W. Milner	Do.
3453	1	Saint Louis, Mo		Dr. Geo. Engleman	Do.
11949	2	Wheatland, Ind	1881	Robt. Ridgway	Do.
13323	1	Washington, D. C		Geo. Shoemaker	Do.
11479	1	Hemlock Lake, Livingston County, N. Y	1880	S. C. Brown	Do.
11512	1	(?)		(?)	Do.

RECAPITULATION.

The number of existing species of batrachia of North America known, and described in the preceding pages, and the families to which they belong, are as follows:

Group.	Family.	Genera.	Species.
Proteida	Proteidæ	1	2
Urodela	Cryptobranchidæ	1	2
	Amphiumidæ	1	1
	Desmognathidæ	1	3
	Plethodontidæ	8	24
	Amblystomidæ	4	21
	Pleurodelidæ	1	2
Total		16	53
Trachystomata	Sirenidæ	2	2
Salientia	Bufonidæ	1	11
	Scaphiopodidæ	2	4
	Cystignathidæ	3	3
	Hylidæ	4	17
	Engystomidæ	1	1
	Phryniscidæ	1	1
	Ranidæ	1	13
Total		12	50
Grand total		31	107

ADDENDA.

The following notes were too late for insertion into the body of the book:

AMBLYSTOMA TIGRINUM Green. (p. 84).

Don José M. Velasco asserts that the *Siredon mexicanus* (*S. humboldtii*) undergoes a metamorphosis, but he nowhere describes the adult. He did observe in 1878* the metamorphosis of the *Amblystoma tigrinum* in specimens from Lake Santa Isabel, three miles north of the City of Mexico. It does not appear that he discriminates between the two species, so that when he states that the *S. mexicanus* is found in Lake Zumpango, thirty-two miles north of the City of Mexico, we are not certain whether it may not be the *A. tigrinum* to which he refers.

The Siredon gracilis and *S. lichenoides* of Baird are both larval forms of the *A. tigrinum*.

Dr. R. W. Shufeldt, U. S. Army, thus describes the metamorphoses of the *Amblystoma tigrinum*, as observed by him at Fort Wingate, N. Mex. (Science, September, 1885, p. 263):

"(1) Axolotls are more readily converted into Amblystomas if kept in water containing but little air, and *vice versa*.

"(2) If transformation is forced up to a certain point in development, the reptile arrives at the higher form without any further interference.

"(3) Axolotls live in the water with apparent comfort a considerable and varying length of time after their gills have been absorbed.

"(4) After the metamorphosis is completed their power to return to the water again to live seems to depend upon the moult, and whether they have lived in moist or dry places since the metamorphosis.

"(5) By varying the conditions under which these animals live, we can at our pleasure retard or accelerate their development to the higher stages.

"(6) Young Axolotls are more easily transformed than the older specimens, but this rule also depends largely upon the conditions under which these animals live.

"There is another very important factor that enters into this metamorphosis that, so far as the previous accounts go, is not touched upon, and that is the question of their diet during the experiments. Axolotls are very voracious creatures and eminently carnivorous.

* La Naturaleza, IV, 1878.

They are very fond of raw meat, and, upon the slightest provocation, they will feed upon each other. So I have found during the course of my experiments that—

"(7) The metamorphosis is hastened by regularly supplying the animals with plenty of proper food. And what is still more interesting, when they are thus treated it markedly affects the appearance of the transformed Amblystomas.

"(8) If, during the process of forcing the transformation of Axolotls, the animals are regularly supplied with the requisite amount of fresh meat, the transformed Amblystomas are very much larger and stronger than those which are transformed without having received any food. In the case of *A. tigrinum*—those that received food—the transformed animal would hardly have been recognized as the same species; they were not only larger, but of a very deep, muddy, black color, without spots, while the others were mottled with bright yellow and a pale brown.

"(9) The depth of the water has a wonderful influence upon the metamorphosis; and the fact is well known that the deeper the water in which the Axolotls live the slower their transformation.

"Temperature is another important factor in the change, and its moderate increase seems to hasten the transformation.

"Now, the most interesting part of all is to watch the operation of these laws that I have given, in nature, and the manner in which the metamorphosis of Axolotls is there effected.

"It would, indeed, be hard to find anywhere a more perfect and beautiful example illustrating the extremely sensitive balance that may exist between the surrounding conditions on the one hand and their effect upon an animal organism on the other. This year, for instance, the pond that I have observed gradually dried up; the north half of it entirely. This took a number of weeks, but during that time all the modifications of which the metamorphoses of Axolotls are subject to or capable of, were, so far as their necessity goes, most lucidly demonstrated. A shallow corner of this pond would, after a torrid day or two, dry up, whereupon all the Axolotls that happened to be caught within its limits would be found—perhaps several hundred of them—under the débris, rapidly assuming the Amblystoma form.

"Numbers of the same generation, however, in deeper parts, would be unaffected by the change of environment so suddenly precipitated upon their brethren. If the drying up continued, these transformed animals quit the site, and during the next few days could be found under logs, and in other suitable places at some considerable distance from it. On the contrary, should a rain in the mean time fill the pond again and flood over these shallow parts, the transformations were checked, and those with gills and branchiæ in all stages of change once more took to the water. When huddled together in the shallow places, the large and strong ones devoured the smaller and feebler forms; and the differ-

ent appearance of the two was very striking upon the most superficial examination.

"One day in July the whole north half of this pond suddenly ran dry; and I must confess the sight its bottom presented during the following day was one of the most extraordinary, and at the same time most interesting, that I ever beheld, and after what has been said can be better imagined than described. It absolutely swarmed with these creatures, whose organizations were accommodating themselves to the new condition of affairs as rapidly as the laws governing the changes permitted. The study would have furnished food for a small volume.

"Axolotls are also affected by the character of the ponds or swamps they live in, the same species showing all manner of shades in their coloration. Those in shallow ponds, with little or no vegetation and hard clay bottoms, grow to be very light colored, and long retain their larval forms.

"No doubt many such ponds as I have described exist all over this Southwestern country, and a moment's reflection will make it clear to us how the metamorphosis of this creature tends to save thousands of their lives when the region is visited by a protracted drought and their places of water resort fail them. The preservation of the form is thereby to a great extent protected."

A good many of the adults procured by Dr. Shufeldt differ from the typical form in the shortness of the tail; its length from the posterior end of the vent equaling the length from that point to the axilla.

CHONDROTUS CINGULATUS Cope (p. 100).

The following figures of this species were unavoidably omitted from their proper places in the text:

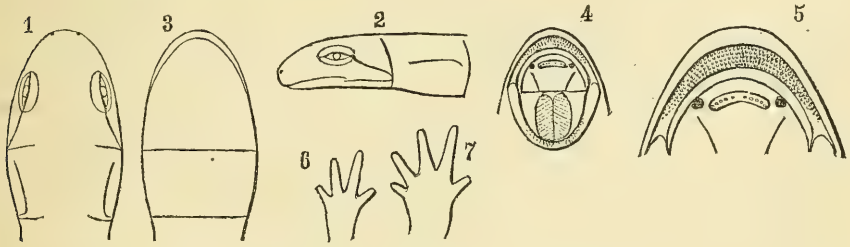


FIG. 116. *Chondrotus cingulatus*. No. 3786. Abbeville, S. C.; ⅔.

SPELERPES RUBER Daud. (p. 172).

Dr. Charles C. Abbott informs me that this species has a distinct whistle-like voice, and states that Mr. John Burroughs has also heard it.

AMPHIUMA MEANS Gard. (p. 216).

Splanchnology.—The bulbus arteriosus is of considerable length, and then gives off an aorta bow on each side, and bifurcates almost immedi-

ately beyond. The large *ductus cuvieri* enters the large auricle opposite the middle of the length of the ventricle. Those vessels at their cardiac terminations are distinctly seen in the large pericardiac sac. The *vena portæ* is very large, and extends along the dorsal side of the liver proximally.

The stomach is scarcely distinguishable. The alimentary canal is only convoluted in the posterior two-fifths of its length, the rectum being distinguishable by its superior diameter and its absence of flexure. The liver is large and not divided, and terminates rather abruptly where the convolutions of the alimentary canal commence. It is attached to the median line by a fold of peritoneum by one edge. Its middle line is grooved, and the groove is occupied by a vessel, and by the edge of the mesentery, which extends to the intestines. In Plate XII it is cut at the proper point to display the large gall-bladder (*g*).

The lungs are not so long as in *Siren lacertina*, not extending beyond the liver. They are of subequal length.

The testis is single and very elongate. It extends from the extremity of the liver to near the outlet of the vas deferens. Parallel to it, and in part attached to it, is a slender, flat body, which I suppose to be the corpus adiposum. The kidney is an elongate, oval, and flat body, emptying by a very short ureter into the cloaca. Its *venæ revehentes* are distinctly visible from the inferior side. The Mullerian duct extends along its exterior border and anterior to it between the lung and the dorsal peritoneum a long distance anteriorly; that is, as far as the proximal fourth of the length of the stomach. The urinary bladder is remarkably elongate, extending forward to the distal end of the liver.

The spleen is elongate, but not so much so as in *Siren lacertina*, equaling about one-third of the stomach, and just reaching the gall-bladder.

Osteology.—According to Mr. F. A. Lucas, who drew the plate of Amphiuma for the present volume, the iliac bones were unsymmetrically attached in the specimen, the one to the sixty-third and the other to the sixty-fourth vertebra (Plate X).

Voice.—Prof. J. A. Ryder, of the University of Pennsylvania, has kept this species in captivity. He states that its voice is so loud that it can be heard from one room to another of the building of the school of biology.

SIREN LACERTINA (p. 226.)

Splanchnology.—The branchial arteries leave the *bulbus arteriosus* near together, scarcely forming a *truncus communis*. The branchial veins, on the other hand, unite on each side into a *truncus communis* or aorta root, which unites with that of the opposite side to form the aorta a considerable distance anterior to the *bulbus arteriosus*. The valve of the bulbus is a longitudinal elevation containing six grooves, one corresponding to each *arteria branchialis*. (Plate XXI, fig. 5*a*.)

Both lungs extend from the heart to the cloaca. The stomach is scarcely distinguishable from the intestine. The latter is large, and is

moderately convoluted. The vessels of the mesentery are large. The mesenteric vein runs along the inferior edge of an elongate body, which is either the spleen or the pancreas. It extends from the stomach for a distance equal to one-third the length of the visceral cavity, terminating near the anterior testis. The liver is large and long, extending from the heart to near the anterior testis. It is divided by a median groove for most of its length, in which the base of the mesentery is attached cardiad of the large gall-bladder. The anterior part of the liver forms a median lobe, which extends for a short distance below the alimentary canal.

There are two pairs of testes, the anterior the longer. The kidneys are flat, oval bodies, lying on each side of the middle line, immediately above the rectum. They open by a short ureter into a fold of the cloaca. The urinary bladder is large and long, extending forwards as far as the anterior extremity of the anterior testis. (Plate XLIV.)

SALIENTIA.

Viscera.—The corpora adiposa are elongated transversely, and frequently fissured at the distal extremity. (Plate LVII.)

The *ductus müllери* is present in Bufo, Scaphiopus, and other genera, but is wanting in Rana, except *Rana virescens* (Sedgwick).

The urinary bladder is large, and is extended from side to side of the inferior part of the abdominal cavity. Its anteroposterior extent is small.

The Rev. W. J. Holland informs me that he has observed in Japan arboreal nests of Batrachia Salientia, in which the embryos developed into tadpoles, which reached a length of nearly an inch, before leaving the nest. The nests are made in willow trees at a distance of from 12 to 14 feet above the water. The dried remains of a nest containing a good many dried ova and tadpoles was sent me by Mr. Holland. The latter are distinguished by the presence of a large persistent food-yolk, as in various Salientia of division II of the table on pages 238 and 239.

BUFO Laur. (p. 261).

Insert at bottom of page 261 in table of species:

One metatarsal tubercle; cranial crests parallel, not produced posteriorly; profile descending; muzzle produced beyond mouth; skin smooth below; a lateral band ..... *B. aduncus.*

One metatarsal tubercle; cranial crests separated, sending a branch inwards posteriorly; parotoid gland triangular; a lateral light band ..... *B. valliceps.*

BUFO ADUNCUS, sp. nov.

This very distinct species has the cranial crests of the *B. lentiginosus* type, more especially resembling the *B. l. fowlerii*. It differs especially from that species in the very short, wide head, with depressed muzzle overhanging the mouth, in the perfectly smooth inferior surfaces, and in the coloration, as well as in various minor details.

The head is wider than long, the width entering the length 2.25 times, while the length enters it three times. The entire profile is steeply decurved, and terminates in a prominent muzzle, which projects considerably beyond the upper lip. The nostril is lateral and nearly terminal. The lip border is directly below a point half-way between the nostril and the orbit. The maxillary bone is somewhat contracted to the lip border. The prefrontal bones are obtusely angulated above, but the cranial crests commence with the frontoparietal bones. They are parallel, rather near together, and are well distinguished everywhere. They form a right angle with the postorbitals, beyond which they are not produced, nor is there any tendency to confluence posteriorly. A short, robust supratympanic ridge. Orbit large; tympanic disk oblique, the long axis directed upwards and forwards, and a little shorter than the eye-fissure. Skin above with small warts at considerable distances apart; below everywhere smooth. Parotoids indistinct in the specimen, their superior borders strongly divergent from the middle line posteriorly. Limbs rather long. The muzzle marks the middle of the fore-arm, and the distal end of the tarsus of the extended limbs. First finger longer than second; second connected with first and third fingers by a short web. Palmar tubercle longer than usual. Toes closely bound together, the fourth considerably longer than any of the others. The internal cuneiform tubercle has a free edge, which is not black; the external tubercle is small. The femur is bound to the middle by the skin of the side of the body.

Measurements.

	M.
Length of head and body	.044
Length of head to end of crests	.0105
Width of head at canthus oris	.0195
Width of head between orbits	.003
Length of fore leg	.029
Length of fore foot	.012
Length of hind leg from ilium	.061
Length of hind foot	.028
Length of hind foot less tarsus	.019

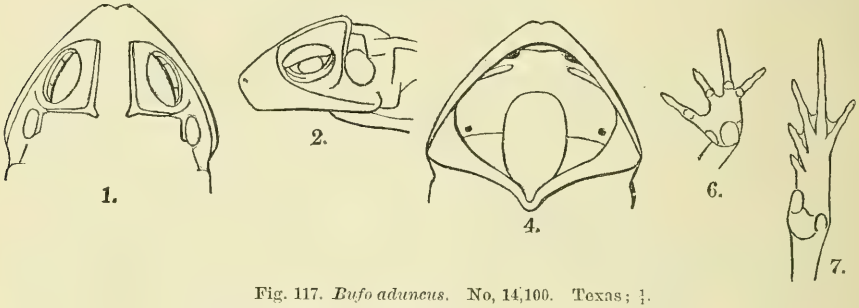


Fig. 117. *Bufo aduncus*. No. 14,100. Texas; ½.

The general coloration is rather light lead colored, and below clear yellowish-white. The small warts above are red, with a black ring at the

base. No median dorsal band. A light band commences on the scapula and extends nearly to the groin. It is bounded above by separate blackish spots, and below by similar spots, which are closer together. These form the superior border of a lead-colored band. This disappears below in a crowd of small black spots, which grow smaller and disappear on the sides of the abdomen. The integument thus marked is areolated. All the lighter parts of this region are dotted with small pink spots. Posterior faces of fore-arm, femur, tarsus, and external metatarsi blackish, with small yellow speckles. The limbs have on their upper surfaces brown cross-bands with pink points in them. Anterior face of tarsus with a brown spot, and several on the external digits.

Catalogue number.	No. of speci.	Locality.	From whom received.	Nature of specimen.
14100	1	Texas	G. H. Ragsdale	Alcoholic.

This species is well characterized by the length of its legs, the short and peculiar form of its head, the smoothness of its lower surfaces, and the color. Though not stated on the label, the specimen described is probably from Gainsboro, in Central Northern Texas.

HYLA ANDERSONII Baird (p. 365).

The Rev. Dr. John E. Peters informs me that he took a specimen of this rare tree-frog near May's Landing, N. J. This is the third individual that has been found, and the locality is not far from that at which Dr. Leutz took the second one. Dr. Peters found the specimen on the ground near a piece of water. Its note is unlike that of *Hyla versicolor*, being a hoarse peep-peep, or, according to Dr. Abbott, a keck-keck.

CHOROPHILUS NIGRITUS Le. C. (p. 338).

The following drawings represent the parts of the type specimen of the form *C. n. verrucosus* Cope, from Florida, which was not inserted

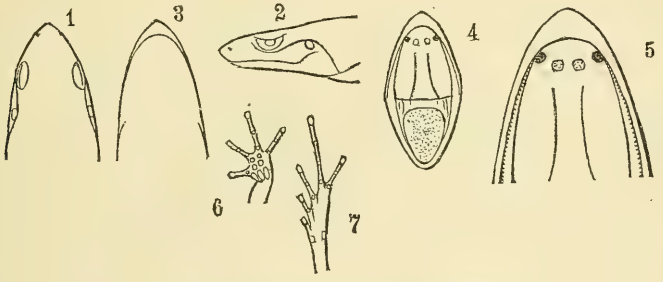


Fig. 118. *Chorophilus nigritus verrucosus.* Volusia, Fla.; ♀.

at the proper place in the text. The type specimen is in my private collection.

ACRIS GRYLLUS Lec C. (p. 324).

Prof. A. E. Verrill tells me that he has seen a few specimens of this species near New Haven, Conn., and that he considers that place to be about the northern limit of its range.

AMPHIGNATHODONTIDÆ.

The following figure of the mouth and feet of the *Grypiscus umbrinus* Cope, in illustration of the above family, was omitted from its proper

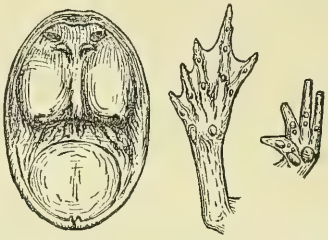


Fig. 119. *Grypiscus umbrinus.* Rio Janeiro; ½.

page. The specimen figure is from Rio Janeiro, and is in the Museum of Comparative Zoölogy of Cambridge.

BUFONIDÆ (p. 260).

For the generic name *Ollotis*, in the key, substitute *Nannophryne* Gthr. (1873), which has two years priority.

CYSTIGNATHIDÆ (p. 313).

Insert under *Hylodes*, immediately after *Malachylodes*, the following:

Vomerine teeth present ..... *Batrachyla* Bell.

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LIST OF CUTS.

[EXPLANATION OF NUMBERS IN ALL THE FIGURES.—1. Head from above; 2. Do. from side; 3. Do. from below; 4. Interior of mouth; 5. Palate enlarged; 6. Fore foot, from below; 7. Hind foot, from below.]

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EXPLANATION OF LETTERING ON PLATES.

A.—*The cartilages, ligaments, and muscles.*

A. p. Ascending process of suspensorium.
A. s. c. Anterior semicircular canal.
At. Annulus tympanicus.
B. Balancer.
Bb. I, II, etc. Basibranchials I, II, etc.
Cb., cbr., I, II, etc. Ceratobranchials I, II, etc.
Ch. Ceratohyal.
Ctr. Cornu trabeculæ.
E. Br. I, II, etc. Epibrachials.
Ecor. Epicoracoid.
Epa. Ethmopalatine.
Epg. Epipterygoid.
Est. Epistapedial.
Eth. Pars ethmoidea.
Eu. Eustachian ligament.
HM. Hyomandibular.
HQ. Hyoquadrate ligament.
HS. Hyosuspensorial ligament.
Hsc. Horizontal semicircular canal.
Il. Inferior labial.
Inc. Internasal cartilage.
Ll. Lower labial.
Mh. Mandibulo-hyoid ligament.
MK. Meckels cartilage.
Mst. Mesostapedial.
Na. Nasal roof cartilages.
Nc. Notochord.
OG^1, OG^2. Otoglossal: 1, cartilaginous; 2, fibrous.
Pbc. Pubic cartilage.
Pca. Trabeculoquadrate cart.
Pd. Pedicle of suspensorium.
Pg. Pterygoid.
Proc. Procoracoid.
Psc. Posterior semicircular canal.
Q. Qc. Quadrate.
Sl. Superior labial.
SSC. Suprascapula.
St. M. Musculus stapedius.
St. Stapes.
Tcr. Tegmen cranii.
Tr. Trabeculum.
Trab. Plate. Trabecular plate.
T. ty. Tegmen tympani.

B.—*The bones.*

Als. Alisphenoid.
Ang. Angular.
a. r.; a. r. t. Articulare.
As. Astragalus.
a. s. c. Anterior semicircular canal.
a. t. r. Apex of trabecule.
au. Auditory capsule.
B. br. Basibranchial.
B. hy. Basihyal.
B. o. Basioccipital.
C. Urostyle.
Ca. Calcaneum.
C. br. Ceratobranchial.
C. c. Centrale carpi.
C. hy. Ceratohyal.
Cl. Clavicle.
Co. Columella.
Cor. Coracoid.
Cu. Cuneiform.
D. Dentary.
Di. Diapophysis.
Eb. Epibranchial.
Ecor. Epicoracoid.
E. eth. Ectethmoid.
ep. Epiotic.
Eth. Ethmoid.
ExO., Eo. Exoccipital.
f. Fibulare.
Fe. Femur.
F. P. Frontoparietal.
Fr., F. Frontal.
H. Humerus.
H. hy. Hypohyal.
Hy. Hypopophysis.
I. Intermedium.
Il. Ilium.
Int. Intercalare.
Is. Ischium.
Ist. Interstapedial.

J. Jugal.
L. Lunar.
M., Mx. Maxillary.
Mn. Mandible.
N., Na. Nasal.
Npr. Nasopremaxillary.
N. px. Nasal process of premaxillary.
N. sp. Neural spine.
Occ. Occipital condyle.
Odv. Odontoid vertebra.
Opo. Intercalare.
Os. Orbitosphenoid.
Ost. Omosternum.
Pal., Pa. Palatine.
Pas., par. Parasphenoid.
Pb. Pubis.
P. cor. Precoracoid.
Pef., P.F. Prefrontal.
Pez. Prezygopophysis.
Pg. Pterygoid.
Pmx., px. Premaxillary.
Po. F. Postfrontal.
Poz. Postzygopophysis.
P. Pa. Parietal.
P., pa. Posterior palatine.
P. pg. Palatopterygoid.
P. px. Palatine part of premaxillary.
Pro. Proötic.
Ps. Parasphenoid.
Pt., Pg. Pterygoid.
Ptr. Pretransverse process.
Qj. Quadratojugal.
Qst. Quadratostapedial articulation.
Qu., Q. Quadrate.
R. Rib.
r. Radiale carpi.
S. Scaphoid.
Sa. Sacrum.
Sca., Sc. Scapula.
Smx. Septomaxillary.
So. Supraoccipital.
Sp. Splenial.
Spe. Sphenethmoid.
Spt. Squama palatina.
Sq. Squamosal.
SSc. Suprascapula.
St. Sternum.
St., Stp. Stapes.
Sy. Symphyseal.
T. Tibiale.
Tib. Tibia.
Tr. Temporal ridge.
U. Ulnare carpi.
u. Ulnare.
UR. Ulnoradius.
U. S. Urostyle.
Vo. Vomer.
Vp., Vop. Vomeropalatine.

C.—Foramina and nerves.

Car. Foramen carotideum.
En. External nostril.
Fm. Foramen magnum.
Fo., Font. Fontanelle.
Fso. Fenestra ovalis.
G. Gasserian ganglion.
Hsc. Horizontal semicircular canal.
In. Internal nostril.
Mnp. Middle nasal passage.
Nerves. 1. Olfactory nerve.
2. Optic nerve.
5. Trigeminal nerve.
5^1. First or orbitonasal branch of trigeminal.
5^2–5^3. Maxillary and mandibular branches of trigeminal.
7. Facial.
7^1. Palatine ("vidian") branch of facial.
8. Auditory nerve.
9. Glossopharyngeal.
10. Vagus nerve.
Ol. Olfactory capsule.
Olf., Ol., Nervus olfactorius.
Py. Pituitary body, space, or region.

D.—*Viscera and central nervous system.*

AB. Arteria branchialis; aorta bow.
AM. Arteria mesenterica.
Ao. Aorta.
Au. Auricle.
B. Branchia.
BA. Bulbus arteriosus.
Bc. Branchial chamber.
Bf. Branchial fissure.
Br. Branchiæ.
c. Cistus urinatorius; urinary bladder.
CA. Corpus adiposum.
cl. Cloaca.
DC. Ductus cuvieri.
d. c. Ductus choledochus; diacœlia.
E. Eye.
Eah. Epidermal adhesive organs.
Eb. External branchiæ.
EE. Epencephalon (cerebellum).
Ep. Epiphysis (pineal body).
Fo. Fontanelle of oviduct.
gb. Gall bladder.

H. Heart.
Hv. Hepatic vein.
Hyp, Hy. Hypophysis (pituitary body).
I, i. Intestine.
K. Kidney.
l. Lung.
li., liv. Liver.
l. ant. Anterior lobe of liver.
l. in. Large intestine.
M. Mouth.
ME. Mesencephalon.
MD. Müllerian duct.
Med. Mediastinum.
Mes. Mesentery.
MO. Mouth of oviduct in cloaca.
n. Nerves.
O. Oviducts.
O′. Fontanelle of oviduct.
Oes. Œsophagus.
Ov. Ovary.
P. Pancreas.
P. c. Plexus choroïdeus.
Pe. Prosencephalon.
Pf. Peritoneal fold.
Ph. Pharynx.
Pp. Pappillæ cloacæ.
Py. Pylorus.
r. Rectum.
Rh. Rhinencephalon.
S. in. Small intestine.
Sp. Spleen.
Spx. Supraplexus.
St., Stom. Stomach.
Sv. Sinus venosus.
T, t. Testis.
TE. Thalamencephalon.
Ur. Ureter.
Ut. Urethra.
V. Ventricle of head.
V. B. Vena branchialis.
Vca. Vena cava ascendens.
Vd. Vas deferens.
Ve., Vek. Vena efferens of the kidney.
Vet. Vena efferens of the testis.
Vl. Left ventricle.
VM. Vena mesenterica.
VP. Vena portae.
Vp. Vena pulmonalis.
Vr. Right ventricle.
Viv. Fourth ventricle.
Ventricles of the brain I, II, III, IV, V.
V. l. Lateral ventricle.
Vre. Venæ revehentes renales.

EXPLANATIONS OF PLATES.

PLATE I.

Necturus maculatus, skeleton from below, two-thirds natural size

PLATE II.

Necturus maculatus, natural size.

FIG. 1. Skull, superior view.
2. Skull, inferior view.
3. Skull, left side, exterior view.
4. Skull, left side, interior view.
5. First and second vertebræ, from below.
6. First and second vertebræ, from above.
7. First and second vertebræ, right side.
8. Atlas, from front.
9. Second vertebræ, from behind.

PLATE III.

(Copied from Wiedersheim's Kopfskelet der Urodelen.)

FIG. 1. *Necturus maculatus*, skull, from below, displaying the chondrocranium of one side.
2. *Necturus maculatus*, skull, from above, displaying the cartilaginous nasal capsules.
3. *Cryptobranchus allegheniensis*, skull, left side.
4. *Cryptobranchus allegheniensis*, skull, from above, showing chondrocranium of one side.
5. *Cryptobranchus allegheniensis*, skull, from below, showing cartilages of one side.

PLATE IV.

Necturus maculatus, two-thirds natural size, from below, showing viscera, mostly in place; the alimentary canal and corpus adiposum displaced to the right side of the animal.

PLATE V.

Cryptobranchus allegheniensis, skeleton, from above, half natural size.

PLATE VI.

Cryptobranchus allegheniensis, skeleton, from below, half natural size.

PLATE VII.

Cryptobranchus allegheniensis, viscera from below in position, two-thirds natural size. Drawn by Prof. S. F. Baird. *a*, auricle; *v*, ventricle of heart; *L*, liver; *m*, mediastinum; *s*, stomach; *i*, intestines; *o*, oviduct; o^1, fontanelle of oviduct; *g*, gall-bladder; *r*, rectum; *c*, urinary bladder.

PLATE VIII.

Cryptobranchus allegheniensis, skull.

FIG. 1. Superior face.
2. Inferior face.
3. Left side, exterior.
4. Left side, interior.
5. Left mandibular ramus, external side.
6. Left mandibular ramus, internal side.

PLATE IX.

(Copied from Wiedersheim's Kopfskelet der Urodelen.)

FIG. 1. *Siren lacertina*, skull, left side.
2. *Siren lacertina*, skull, from above, one-half the cartilage exposed.
3. *Siren lacertina*, skull, from below, one-half the cartilage exposed.
4. *Proteus anguinus*, skull, left side.
5. *Proteus anguinus*, skull, from above.
6. *Proteus anguinus*, skull, from below.
7. *Amphiuma means*, skull, left side.

PLATE X.

Amphiuma means, skeleton, from below, two-thirds natural size.

PLATE XI.

Amphiuma means, one-third natural size; from Georgia. Copied from Cope, Proceedings of the American Philosophical Society, 1886, p. 442.

FIG. 1. Skull, left side.
2. Skull, from above.
3. Skull, from below.
4. Skull, right half, from within.
5. Left mandibular ramus, external view.
6–9. An anterior dorsal vertebra; fig. 6, front; 7, rear; 8, bottom; 9, top.

Chthonerpeton indistinctum, R. & L., three-eighths natural size; from Brazil. Copied from Wiedersheim, Die Anatomie der Gymnophionen.

FIG. 1. Skull, from above.
2. Skull, from below.
3. Skull, left half, from within.
4–6. One and parts of two other vertebræ; 4, from above; 5, from below; 6, right side.

PLATE XII.

Amphiuma means Gard. three-toed form; viscera in place, except that the alimentary canal is displaced to the right side of the animal. Two-thirds natural size.

PLATE XIII.

Hyoid apparatus of Batrachia. Figs. 1, 3, 5, 6 dissected and drawn by E. E. Galt; 2, 4, and 7, by E. D. Cope.

FIG. 1. *Necturus maculatus*, small, × 3.
2. *Proteus anguinus*, adult, ¼.
3. *Cryptobranchus allegheniensis*, adult, ¼.
4. *Megalobatrachus maximus*, adult, ¼.
5. *Amphiuma means*, small, × 4.
6. *Siren lacertina*, small, × 4.
7. *Ichthyophis glutinosus*, ¼.

PLATE XIV.

Skeleton of *Amblystoma punctatum*, one-half natural size; superior view. No. 722.

PLATE XV.

Amblystoma punctatum, skeleton from below; natural size.

PLATE XVI.

Amblystoma punctatum, skull, one-half larger than natural size.

FIG. 1. Skull, above.
2. Skull, below.
3. Skull, left side, exterior.
4. Skull, left side, interior. The numbers below are those of the nerves which issue from the foramina of the figure.

PLATE XVII.

Visceral anatomy of *Amblystoma punctatum*, from drawings by Prof. S. F. Baird.

FIG. 1. Viscera in place, from below.
2. Liver, from above; *a*, from below.
3. Corpora adiposa and ovaries; one outlined only.
4. Larynx, lungs, stomach, and spleen isolated.

PLATE XVIII.

Amblystoma punctatum, development of larva, from drawings by Prof. S. F. Baird, magnified four diameters.

FIG. 1. Embryo taken from egg 4 lines in diameter, × 4.
2. Another embryo, from above; *a* from below.
3. Larva just from the egg, from below, × 8.
4. Larva two weeks free from egg, with three digits on manus, from above; *a*, from side; × 4; May, 11, 1848.
5. Larger larva, with posterior limbs, from above, × 4. "In six individuals, all had the right branchiæ less developed than the left;" note S. F. Baird.
6. Hind limb before development of digits.
7. Right fore-foot, from above, of specimen older than fig. 4; 5-25, 1848.
8. Eye of fig. 4, showing lens.

PLATE XIX.

Amblystoma opacum and *Plethodon erythronotus*, skulls, twice natural size.

FIG. 1-3. *Amblystoma opacum*.
4-6. *Plethodon erythronotus*.

PLATE XX.

Anatomy of *Amblystoma opacum*, drawn by Prof. S. F. Baird.

FIG. 1. Viscera in place, from below; lettering as before; female; natural size.
2. Oviducts and fat bodies; natural size; *cl*, cloaca; *fo*, fontanelle of oviduct; *k*, kidney.
3. Stomach and liver; the latter everted, to show portal vessels.
4. Cloaca much enlarged, showing mouths of oviducts and labia (*la.*).
5. Urinary bladder distended.
6. Urogenital system; *C A*, corpus adiposum; *T*, testis; *k*, kidney; *v e t*, vasa efferentia testis; *vek.* vasa efferentia, renis; *v. d.* vas deferens.

PLATE XXI.

Amblystoma sp., viscera, drawn by Prof. S. F. Baird.

FIG. 1. *Amblystoma punctatum*, viscera, natural size, female; the digestive and urogenital systems drawn separately; lettering as before; *cl*, cloaca; June, 1848.
2. *Amblystoma punctatum*, urogenital system of male, enlarged; lettering as before; May, 1849.
3. *Amblystoma opacum* Grav., male, cloaca; 1, vas deferens; 2, ureter; 3, groove from each vas deferens, which unites with its fellow at apex of peninsula (9), and is continued as a branch on each side, dividing and inclosing the process (4), and, reuniting, passes round the posterior part of the folds of membrane (5); 4, oval, fleshy bodies, supported on short stems equal to themselves; 5, a series of deep folds of membrane of each side, nearly meeting inferiorly; 6, slight protuberance in the depression between the folds; 7, folds which arise between the bodies (4) as one, and, bifurcating, sink away behind the folds (5); 8, a second set of folds anterior to 7.
4. *Amblystoma opacum*, liver from above; *a*, from below.
5. Heart and branchial vessels of *Siren lacertina*, diagrammatic; *a*, transverse section of *bulbus arteriosus*.

PLATE XXII.

Chondrotus tenebrosus, skeleton of larva, from above, natural size. Fig. 1, skull from below; 2, lower jaw and hyoid arches from above. From Salem, Oregon.

PLATE XXIII.

Chondrotus tenebrosus, larva, natural size, from below.

PLATE XXIV.

Hyoid apparatus of *Amblystomidæ;* Figs. 1, 2, and 3 dissected and drawn by Dr. E. E. Galt; the remainder by E. D. Cope.

FIG. 1. *Chondrotus tenebrosus*, from below; $\frac{1}{1}$.
2. *Chondrotus tenebrosus*, larva, from above; × 2.
3. *Chondrotus tenebrosus*, larva, from below; × 2.
4. *Chondrotus aterrimus*, from below; $\frac{3}{2}$.
5. *Chondrotus aterrimus*, from above; $\frac{3}{2}$.
6. *Chondrotus paroticus*, from below; $\frac{3}{2}$.
7. *Chondrotus paroticus*, from above; $\frac{3}{2}$.
8. *Chondrotus decorticatus*, from below; $\frac{3}{2}$.
9. *Chondrotus decorticatus*, from above; $\frac{3}{2}$.
10. *Linguælapsus annulatus*, from below; $\frac{2}{1}$.
11. *Linguælapsus annulatus*, from above; $\frac{2}{1}$.
12. *Linguælapsus lepturus*, from above; $\frac{2}{1}$.
13. *Linguælapsus lepturus*, from below; $\frac{2}{1}$.

PLATE XXV.

Hyoid apparatus of *Amblystomidæ* and *Hynobiidæ;* Figs. 1, 2, 8, and 9 dissected drawn by E. D. Cope; 3–7 by E. E. Galt, and 10, 11 from R. Wiedersheim.

FIG. 1. *Chondrotus microstomus*, from below; × 4.
2. *Chondrotus microstomus*, from above; × 4.
3. *Chondrotus tenebrosus*, larva, side view; × 2.

FIG. 4. *Amblystoma punctatum*, from below; × 2.
5. *Amblystoma punctatum*, larva, side; 5.
6. *Amblystoma macrodactylum*, from below; × 2.
7. *Amblystoma tigrinum*, from below; × 2.
8. *Amblystoma epixanthum*, from above; × 3.
9. *Amblystoma jeffersonianum*, from above; × 3.
10. *Hynobius nævius*.
11. *Ranidens sibiricus*.

PLATE XXVI.

Plethodon glutinosus, skull, twice natural size.

FIG. 1. Skull, above.
2. Skull, below.
3. Skull, left side.
4. Skull with mandible, from behind.

PLATE XXVII.

FIG. 1–4. *Autodax lugubris*, skull, natural size.
1. From left side, exterior.
2. From above.
3. From below.
4. Left side, interior.

FIG. 5–7. *Manculus quadridigitatus*, three times natural size.
6. Skull, from above.
7. Skull, from below.
5. Skull, from left side.

PLATE XXVIII.

FIG. 1–3. *Spelerpes longicauda*, skull, twice natural size, with cervical vertebræ.
1. Skull, above.
2. Skull, below.
3. Skull, left side.

4–6. *Spelerpes bilineata*, skull, three times natural size, with three cervical vertebræ.
4. Skull, above.
5. Skull, below.
6. Skull, left side.

PLATE XXIX.

Spelerpes ruber, skulls of larva and adult, twice natural size.

FIG. 1–3. Larva nearly mature.
1. Skull and three vertebræ, from above.
2. Skull and three vertebræ, from below.
3. Skull and three vertebræ, from left side.

4–6. Skull of adult.
4. From above.
5. From below.
6. From left side.

PLATE XXX.

(Copied from Parker. *Spelerpes ruber*, skulls of adult and larva, much enlarged.)

FIG. 1–2. *Spelerpes ruber*, larva, younger than that represented in the last plate (xxix).
1. Skull, from above.
2. Skull, from below.

FIG. 3–5. Adult.
3. From above.
4. From below.
5. From right side.
6. *Gyrinophilus porphyriticus,* part of right side of skull of larva, showing trabecula, etc.

PLATE XXXI.

Spelerpes ruber, viscera, ♀, drawn by S. F. Baird.

FIG. 1. Viscera, in situ, natural size; eggs nearly ready for expulsion. Lettering as before. 1*a*. The heart removed. *Vca*, ascending vena cava; *A*, auricle; *VP*, *vena pulmonalis*; *v*, ventricle; *Ba*, bulbus arteriosus; *ccA*, canalis communis arteriosus.
2. Fontanelle of oviduct, near stomach.
3. Left ovary with corpus adiposum on left side.
4. Liver; *a*, from below.
5. Cloaca and kidney, with vasa efferentia renis and vas deferens.
6. *Plethodon glutinosus,* ♀, kidneys, from below: *v e* k^1 vasa efferentia renis stretched out of place to show their course, on left of figure.

PLATE XXXII.

Bones of Urodela three times natural size; drawings by Prof. S. F. Baird.

FIG. 1. Scapular arch of one side of *Sp elerpes ruber* which has just passed its metamorphosis; the branchiæ not quite obliterated; Carlisle, Pa., June 12, 1849.
2. Humerus of the same.
3. Cubitus and manus of the same.
4. *Amblystoma punctatum,* posterior leg of larva just changing to the adult.

PLATE XXXIII.

Skulls of *Gyrinophilus porphyriticus.*

FIG. 1–3. Skull of adult, natural size.
1. From above.
2. From below.
3. From left side.
4–6. Skull of advanced larva, twice natural size.
4. From above.
5. From below.
6. From left side.

PLATE XXXIV.

(Copied from W. R. Parker.)

FIG. 1–4. *Gyrinophilus porphyriticus,* larvæ, much enlarged.
1–2. Larva less advanced than that represented in Plate XXXIII.
1. From above.
2. From below.
3–4. Larva still less advanced than that represented in figs. 1, 2.
3. From above.
4. From below.
5–6. *Desmognathus fusca,* skull.
5. From above.
6. From below.

PLATE XXXV.

Hyoid apparatus of Plethodontidæ, dissected and drawn by Dr. E. E. Galt, excepting figs. 11 and 12.

FIG. 1. *Plethodon oregonensis*, inferior view, × 2.
2. *Plethodon glutinosus*, inferior view, × 2.
3. *Autodax lugubris*, inferior view, × 2.
4. *Batrachoseps attenuatus*, inferior view, × 3.
5. *Hemidactylium scutatum*, inferior view, × 3.
6. *Gyrinophilus porphyriticus*, inferior view, × 3.
7. *Spelerpes ruber*, superior view, × 3.
8. *Spelerpes ruber*, inferior view, × 3.
9. *Spelerpes ruber*, larva, superior view, × 4.
10. *Spelerpes ruber*, larva, inferior view, × 4.
11. *Spelerpes longicaudus*, inferior view.
12. *Manculus quadridigitatus*, inferior view.

PLATE XXXVI.

Hyoid apparatus of Urodela.

FIG. 1. *Desmognathus fusca*, inferior view, × 3; Dr. Galt.
2. *Diemyctylus torosus*, inferior view, × 2; Dr. Galt.
3. *Diemyctylus viridescens*, superior view, × 2; Dr. Galt.
4. *Diemyctylus viridescens*, lateral view, × 2.
5. *Diemyctylus palmatus*, inferior view, × 3.
6. *Salamandrina perspicillata*, inferior view, × 6; from Parker.
7. *Salamandrina perspicillata*, larva, inferior view, × 6; from Parker.
8. *Hemisalamandra cristata*, × 2; inferior view.
9. *Chioglossa lusitanica*, inferior view, × 3.

PLATE XXXVII.

FIG. 1. *Salamandra maculosa*, skeleton, natural size.
2. *Thorius pennatulus*, skull, from side, × 4.
3. *Thorius pennatulus*, skull, from above, × 4.
4. *Thorius pennatulus*, skull, from below, × 4.

PLATE XXXVIII.

FIG. 1–4. *Diemyctylus torosus*, skull, much enlarged; copied from Parker.
1. From above.
2. From below.
3. Right mandibular ramus, external view.
4. Right mandibular ramus, internal view.

5–9. *Salamandrina perspicillata*, skull; copied from Wiedersheim.
5. Skull, from above.
6. Skull, from below.
7. Skull, from left side.
8. Skull, from front.
9. Skull, from behind.

PLATE XXXIX.

Diemyctylus viridescens, much enlarged; copied from Parker.

FIG. 1. Skull of adult, from above.
2. Right ramus of mandible, inner side.

FIG. 3. Hyoid apparatus of adult, from below.
4. Skull of larva, from above.
5. Skull of larva, from below.
6. Hyoid apparatus of larva, from above.
7. Basis cranii of very young larva.

PLATE XL.

Urodela, viscera isolated and much enlarged. From drawing by Prof. S. F. Baird.

FIG. 1–2. *Spelerpes ruber*, kidney and vas deferens, ♂.
1. The tubules of the kidney displayed from above; *a*, in greater detail from below.
2. The vasa efferentia; diagrammatic.
3. *Gyrinophilus porphyriticus*, liver and central circulatory system of a large larva.
4. *Plethodon glutinosus*, ♀, liver, natural size.
5–9. *Diemyctylus viridescens*, ♂.
5, 6. Reproductive organs and cloaca of male.
7. Right corpus adiposum, inferior surface, × 4.
8. Testis.
9. Kidney, vas deferens, and vasa efferentia.

PLATE XLI.

Central nervous system of Urodela, enlarged.

FIG. 1. *Spelerpes ruber*, from above; *a*, from below.
2. *Amblystoma punctatum*, ♀, brain and cranial nerves of the left side from below. The cranial nerves are numbered. *G*, Gasserian ganglion; *Co*, connecting branch between trigeminus and facial nerves; *L*, part of labyrinth.
3. *Diemyctylus viridescens*, brain, from above; *a*, from below; *b*, from left side; *Pe*, prosencephalon; *Ep*, epiphysis; *TE*, thalamencephalon; *ME*, mesencephalon; *EE*, epencephalon; *IV*, fourth ventricle; *Hyp*, hypophysis.
4. *Diemyctylus viridescens*, semicircular canals.

PLATE XLII.

Larval and breeding stages of Salamanders.

FIG. 1. *Gyrinophilus porphyriticus* larva, natural size; June 3.
2. *Spelerpes longicaudus* larva × 4; May 29.
3. *Diemyctylus viridescens*, breeding male, natural size; *a* inferior side of hind leg, showing corneous nuptial excrescences, and tips of digits.

PLATE XLIII.

Siren lacertina, skeleton from below, two-thirds natural size.

PLATE XLIV.

Siren lacertina, splanchnology; three-fifths natural size.

For lettering see general explanation. The mesentery is divided so that the alimentary canal can be extended outward to the right side, so as to display the other organs. The lines VM and Mes, on the right of it, extending from the testes to the gall-bladder represent the borders of the gap opened by the section. The cloaca is divided, exposing the mouths of the urethra and ureters. For heart and vessels see Plate 19, fig. 5.

PLATE XLV.

Carpus and tarsus of Rhachitomi and Urodela, natural size, excepting Fig. 1, which is one-half natural size.

FIG. 1. Carpus of *Eryops megacephalus* Cope, from the Permian formation of Texas.
2. *Necturus maculatus*, carpus and tarsus.
3. *Cryptobranchus allegheniensis*, carpus and tarsus.
4. *Amblystoma opacum*, carpus and tarsus.
5. *Plethodon glutinosus*, carpus and tarsus.
6. *Spelerpes ruber*, carpus and tarsus.
7. *Desmognathus fusca*, tarsus.
8. *Diemyctylus torosus*, carpus and tarsus.
9. *Diemyctylus viridescens*, carpus and tarsus.

PLATE XLVI.

Carpus and tarsus of Batrachia, from drawings made by Dr. George Baur, enlarged, except Figs. 2 and 9, which are natural size.

FIG. 1. *Necturus maculatus*, young of, 31 mm × 30; *a* carpus, *b* tarsus.
2. *Megalobatrachus japonicus*, natural size; *a* carpus, *b-c* tarsus.
3. *Cryptobranchus allegheniensis*, tarsus ½.
4. *Amphiuma means*, *a-b* carpus; *c* tarsus; × 50.
5. *Siren lacertina*, carpus × 2.
6. *Onychodactylus japonicus*, *a* carpus, *b* tarsus.
7. *Geotriton fuscus*, tarsus × 6.
8. *Hemidactylium scutatum*, tarsus × 8.
9. *Archegosaurus decheni* Von Meyer, from a specimen in the Museum of Tübingen; drawn by A. Froriep; natural size.

PLATE XLVII.

Carpus and tarsus of European Batrachia, much enlarged. From Gegenbaur, Untersuchungen zur Vergl. Anatomie d. Wirbelthiere. I Heft. Carpus u. tarsus.

FIG. 1–2. *Proteus anguinus*, carpus and tarsus; 1 carpus, 2 tarsus.
3. *Salamandra maculosa* larva, carpus.
4. *Salamandra maculosa* larva, tarsus.
5. *Salamandra maculosa* adult, carpus.
6. *Salamandra maculosa* adult, tarsus.
7. *Molge vulgaris*, carpus.
8. *Molge vulgaris*, tarsus.
9. *Bombinator igneus*, carpus.
10. *Bombinator igneus*, tarsus.
11. *Phryniscus crucifer*, carpus.
12. *Rana temporaria*, carpus.
13. *Rana esculenta*, tarsus.

PLATE XLVIII.

The relations of the quadrate, stapedial, and hyoid apparatus. In Figs. 1, 3, 9, 14,15, and 16 the squamosal bone has been removed. Figures twice natural size, excepting 1, 3, 4, 7, and 8, which are natural size, and 10, 11, and 12, which are three times natural size. From Cope in the American Journal of Morphology, 1888.

FIG. 1. *Necturus maculatus;* squamosal removed.
2. *Proteus anguinus.*
3. *Cryptobranchus allegheniensis;* the middle of the squamosal removed, the extremities remaining.

FIG. 4. *Amphiuma means.*
5. *Typhlonectes compressicaudus*, from the Belize.
6. *Dermophis mexicanus*, with the quadrate bone turned up, exposing its inferior face, and that of the quadratojugal: 4*a*, the quadrate in normal position. From Mexico.
7. *Chondrotus tenebrosus* larva, 250 mm.
8. *Chondrotus tenebrosus*, adult.
9. *Amblystoma tigrinum* larva; squamosal removed.
10. *Amblystoma punctatum*, adult.
11. *Hemidactylium scutatum.*
12. *Batrachoseps attenuatus.*
13. *Gyrinophilus porphyriticus.*
14. *Plethodon glutinosus;* squamosal removed.
15. *Autodax lugubris;* squamosal removed.
16. *Spelerpes ruber;* squamosal removed.

PLATE XLIX.

The relations of the quadrate, stapedial, and hyoid apparatus in Urodela and Salientia. Figures twice natural size, with separate details larger. From Cope, American Journal of Morphology.

FIG. 1. *Desmognathus nigra*, the squamosal in place; *a*, stapes separate and enlarged.
2. *Salamandra maculata* $\frac{2}{3}$; the squamosal separated.
3. *Diemyctylus torosus*, squamosal removed; *a*, separate squamosal.
4. *Diemyctylus viridescens*, three times natural size, the squamosal removed; 2*a*, the squamosal, external side; *b*, apex of ceratohyal, with hyoquadrate ligament.
5. *Siren lacertina* $\frac{1}{1}$, squamosal in place.
6. *Discoglossus pictus*, partly posterior view; *a*, ear-bones and origin of ceratohyal, enlarged.
7. *Bufo lentiginosus americanus*, the squamosal removed; *a*, the squamosal separate.
8. *Spea hammondii*, the squamosal removed; *a*, the squamosal; *b*, the ear-bones.
9. *Hyla gratiosa*, the squamosal removed; *a*, the squamosal; *b*, the ear-bones and cartilages in profile, the cartilages of the tympanum divided by vertical section; *c*, the ear-bones and cartilages undivided, external view.
10. *Xenopus calcaratus*, partly from behind, with squamosal in place.
11. *Stereocyclops incrassatus*, squamosal in place; *a*, stapes and ear-bones and cartilages.
12. *Rana pretiosa*, squamosal in place; ear-bones and vertically divided cartilages.

PLATE L.

The quadrate, hyoid, and auditory elements. From Cope, American Journal of Morphology, 1888.

FIG. 1. *Rana virescens*, × 2; *a*, squamosal bone; *b*, ear-bones without epistapedial; × 4.
2. *Rana virescens*, larva with hind legs, and developed fore legs concealed; the skull × 2; *a*, the hyoid apparatus from below × 4.
3. *Rana catesbiana*, advanced larva, skull, without hyoid elements, except ceratohyal × 3.
4. *Trimerorhachis insignis* Cope; left posterior part of skull from below, the mandible in place; natural size. From the Permian bed of Texas.

FIG. 5. The same species; another individual; same view, without suspensorium and lower jaw.

6. *Zatrachys serratus* Cope, right posterior part of skull, superior view, showing notch (Ty) for tympanic membrane; natural size; from the Permian bed of Texas.

7. The same specimen as fig. 6, from below, displaying columella or stapes.

PLATE LI.

FIG. 1. *Rana virescens*, hyoid apparatus of larva represented on Plate XLVII, fig. 2, right side, from below; right ceratobranchials cut off distally; × 4.

2. *Rana clamata*, larva, just free from egg × 6; *a*, the same from below.

3. *Rana clamata*, same brood as 2, three days from egg; right gill wanting.

4. *Rana catesbiana*, young larva with small fore leg inclosed in branchial chamber; × 2.

5. *Rana catesbiana* more advanced; fore leg partially protruded from branchial fissure; × 2.

6. *Rana catesbiana*, individual represented in fig. 3, Plate XLVII; fore leg fully protruded, but the branchial fissure (of right side) not closed; × 2.

7. *Rana catesbiana*, same as fig. 4, displaying form of external branchial chamber; × 2.

8. *Rana catesbiana*, larva of age of fig. 5, showing branchial chamber, and the pharynx bounded by a dotted line; × 2.

9. *Rana virescens*, hyoid apparatus of adult, from below.

10. *Rana areolata circulosa*, hyoids from below, ½.

11. *Rana draytoni draytoni*, hyoid apparatus from below, ½.

12. *Rana montezumæ*, hyoid apparatus from below, ½.

13. *Rana cantabrigensis*, hyoid apparatus from below, ½.

14. *Hyla carolinensis*, hyoid apparatus, ½.

15. *Lithodytes latrans*, hyoid apparatus, ½.

16. *Spea multiplicata*, hyoid apparatus from below, ½.

17. *Spea hammondii bombifrons*, hyoid apparatus from below, ½.

18. *Spea hammondii hammondii*, hyoid apparatus from below, ½.

19. *Chondrotus texanus*, hyoid of young just after absorption of branchiæ, × 4.

20. *Typhlonectes compressicaudus*, hyoids, ½.

21. *Dermophis mexicanus*, hyoids, ½.

PLATE LII.

Viscera of Batrachia.

FIG. 1. *Necturus lateralis*.

2. *Amblystoma mexicanum*, larva (Siredon).

3. *Cryptobranchus allegheniensis*.

4. *Amphiuma means*.

Lettering: *P*, pancreas; *oe*, œsophagus; *Pv*, portal vein; *pyl*, pylorus; *g*, gall-bladder; *dc*, ductus choledochus.

PLATE LIII.

Viscera of Batrachia.

FIG. 1. *Siphonops annulatus; c*, urinary bladder.

2. *Salamandra maculosa*.

3. *Pipa americana; py*, pyloric constriction.

4. *Xenopus capensis; dc*, ductus choledochus; *py*, pylorus; *cr*, cæco-rectal constriction.

5. *Bufo* sp.

PLATE LIV.

Digestive apparatus of Salientia

FIG. 1. *Pelobates fuscus.*
2. *Pseudis paradoxa,* larva.
3. *Pleurodema bibroni; py,* pylorus.
4. *Ceratophrys dorsata.*
5. *Leptodactylus typhonius.*
6. *Engystoma microps.*

PLATE LV.

Viscera of Salientia.

FIG. 1. *Bufo melanostictus.*
2. *Hyla cærulea.*
3. *Phyllomedusa bicolor.*
4. *Hemisus guineënse.*
5. *Breviceps gibbosus.*
7. *Rana catesbiana.*

PLATE LVI.

Brains of Batrachia, chiefly Salientia, natural size or enlarged two diameters.

FIG. 1. *Necturus maculatus,* right ventricle exposed; *a,* roof of mesencephalon removed; *b,* floor of mesencephalon enlarged.
2. *Hemisalamandra cristata,* from above; *a,* sagittal section of mesencephalon; *b,* prosencephalon, right ventricle exposed; *c,* floor of mesencephalon, showing commissure *c'* and cerebellum, *epe,* and fourth ventricle, iv; *d,* commissure from behind; *p. c.,* plexus choroïdeus.
3. *Siphonops annulatus* (Mus. Berolin.), from above; *a,* sagittal section, the posterior part of the hemisphere cut off obliquely; *b,* hemispheres spread apart, displaying thalamencephalon and mesencephalon; *c,* prosencephalon, left ventricle exposed; *d,* thalamencephalon with epiphysis, from above; *e,* mesencephalon, epencephalon, and fourth ventricle; *f,* fourth ventricle on removal of cerebellum. Lettering: *pr,* prosencephalon; *me,* mesencephalon; *te,* thalamencephalon; *ee,* epencephalon; *hy,* hypophysis; *ep,* epiphysis; iv, fourth ventricle.
4. *Bufo viridis,* from above, left ventricle exposed; *a,* sagittal section; *p. c.,* plexus choroïdeus.
5. *Epidalea calamita,* with plexus choroïdeus.
6. *Alytes obstetricans.*
7. *Pelobates fuscus.*
8. *Pleurodema bibroni.*
9. *Leptodactylus caliginosus.*
10. *Phrynomantis bifasciatus.*
11. *Breviceps mossambicus.*
12. *Rhinoderma darwinii.*
13. *Atelopus varius; a,* roof of mesencephalon removed, showing floor; *b,* prosencephalon, left ventricle exposed.
14. *Diplopelma ornatum.*
15. *Hylambates maculatus.*
16. *Rana erythraea.*
17. *Rana esculenta,* from above, with plexus choroïdeus removed (p. c.); *a,* right hemisphere removed, left ventricle exposed, and mesencephalon exposed; *b,* left ventricle.
18. *Xenopus capensis; a,* right ventricle and thalamencephalon exposed; *p. c.,* choroid plexus and artery.

PLATE LVII.

Viscera of Salientia with the digestive organs removed. There remain the urogenital, the respiratory, and the central circulatory systems.

FIG. 1. *Bufo lentiginosus americanus*, ♂.
2. *Scaphiopus holbrookii*, ♂.
3. *Rana palustris*, ♀; ovary of the right side removed, so as to display the kidney and oviduct. The greater part of the left lung is also cut off, in order to display the fontanelle of the left oviduct.

PLATE LVIII.

Bufo lentiginosus americanus, skeleton, natural size, from above.

PLATE LIX.

Bufo lentiginosus americanus, skeleton, natural size, from below.

PLATE LX.

Bufo pantherinus, natural size, from below.

PLATE LXI.

Xenopus capensis, natural size, from below.

PLATE LXII.

Ceratophrys ornatus, natural size, from below.

PLATE LXIII.

FIG. 1. *Breviceps gibbosus*, natural size, from below.
2. *Pelobates fuscus*, natural size, from below.

PLATE LXIV.

FIG. 1. *Hyla versicolor*, natural size, from above.
2. *Hyla versicolor* natural size, from below.

PLATE LXV.

Callula pulchra, natural size, from below.

PLATE LXVI.

Rana catesbiana, natural size, from above.

PLATE LXVII.

Rana catesbiana, natural size, from below.

PLATE LXVIII.

Details of osteology of *Salientia*, including *Discoglossidæ*, *Asterophrydidæ*, *Pelodytidæ*, and *Scaphiopidæ*.

FIG. 1. *Spea hammondii hammondii*, cranium from above, and *a* sternum of subspecies *bombifrons*.
2. *Scaphiopus couchii*, sternum.
3. *Scaphiopus holbrookii*, skull and sternum (*a*).
4. *Didocus calcaratus*, skull.
5. *Pelobates fuscus*, sternum of large tadpole.

FIG. 6. *Pelobotes fuscus*, front of skull.
7. *Cultripes provincialis*, skull; from Dugès.
8. *Didocus calcaratus*, sternum.
9. *Megalophrys montanus*, front of skull.
10. *Leptobrachium hasseltii*, skull.
11. *Pelodytes punctatus*, top of skull.
12. *Xenophrys monticola*, front of skull.
13. *Bombinator igneus*, skull; from Parker.
14. *Alytes obstetricans*, skull; from Parker.
15. *Discoglossus pictus*, adult; vertebral column and skull from above; sternum from below.
16. *Discoglossus pictus*, skull of a younger animal from above.

PLATE LXIX.

Including *Pipidæ*, *Xenopidæ*, *Bufonidæ*, and *Rhinophrynidæ*.

FIG. 1. *Pipa americana*, frontoparietal and nasal bones; *a*, sternum, from Boulenger.
2. *Xenopus capensis*, axial part of skull from above; *e*, ethmoid bone; *os*, orbitosphenoid; *n* nasal.
3. *Myobatrachus gouldi*, front of skull from above, with and without prefrontals.
4. *Pseudophryne australis*, skull from above; *a*, sternum.
5. *Epidalea calamita*, skull from above.
6. *Bufo margaritifer*, subsp. *nasicus*, skull from below, the vomers removed, showing palatines; *a*, anterior half of skull from above, part of frontoparietal bone of one side removed to show superior plate of ethmoid.
7. *Bufo spinulosus* (Peru), young animal, with and without prefrontals.
8. *Bufo spinulosus*, adult.
9. *Bufo lentiginosus americanus*.
10. *Bufo delalandi* (Mus., Paris).
11. *Bufo pantherinus;* frontoparietal bone removed on both sides displaying ethmoid.
12. *Bufo carens*.
13. *Bufo cœruleostictus;* *a*, sternum.
14. *Peltaphryne peltacephala*, head.
15. *Otaspis empusa*, head.
16. *Rhinophrynus dorsalis*, front of skull from above.

PLATE LXX.

Cystignathidæ.

FIG. 1. *Pseudis limellum*, skull from above.
2. *Pseudis mantidactyla*, superior axis of skull.
3. *Pseudis paradoxa*, superior axis of skull.
4. *Cyclorhamphus fuliginosus;* skull, separate ethmoid bone, and sternum.
5. *Mixophyes fasciolatus*, cranium from above.
6. *Stombus americanus*, superior axis of skull.
7. *Ceratophrys ornatus*, young; superior axis of skull.
8. *Stombus boiei*, skull with crests from above; *a*, do., axis only; diagrammatic.
9. *Ceretophrys dorsata*, anterior extremity of ethmoid.
10. *Chiroleptes australis*, part of skull of individual not fully mature; *a*, perfect sternum.
11. *Grypiscus umbrinus*, *a*, skull; *b*, sternum, and *c*, sacrum with urostyle.
12. *Calyptocephalus gayi*, head from above.
13. *Limnomedusa macroglossa*, skull and ethmoid; the former showing thin ossification along the sagittal suture.
14. *Cophœus marmoratus*, with separate ethmoid.

FIG. 15. *Borborocœtes tasmaniensis*, cranium.
16. *Borborocœtes peronii*, two skulls.
17. *Helioporus albipunctatus*, skull.
18. *Helioporus albipunctatus*, sternum.

PLATE LXXI.

Cystignathidæ—Continued.

19. *Hyperolia marmorata*, part of cranium, and separate ethmoid.
20. *Hyperolia marmorata*, sternum.
21. *Paludicola brachyops*, cranium.
22. *Lithodytes latrans*, cranium; *a*, sternum.
23. *Rhyncholistris roseus*, with and without prefrontal bones.
24. *Eusophus nodosus*.
25. *Hylorhina œnea*.
26. *Crinia georgiana*, skull and ethmoid.
27. *Alsodes monticola*, frontoparietal bones and sacrum of type specimen.
28. *Pleurodema bibroni*, skull part.
29. *Liuperus marmoratus*, skull part.
30. *Bubonias plicifrons*, skull.
31. *Bubonias plicifrons*, sternum.
32. *Elosia bufonia*, with separate ethnoid.
33. *Elosia nasus*.
34. *Syrrhophus marnockii*.
35. *Crossodactylus gaudichaudii*.
36. *Hylodes lentus*.
37. *Hylodes oxyrhynchus*.
38. *Hylodes martinicensis*.
39. *Leptodactylus caliginosus?*
40. *Leptodactylus ?*
41. *Cystignathus ocellata*.
42. Ungual phalanges of Cystignathidæ. Nos. 5, 6, Hylodes; 23, 24, Cystignathi.

PLATE LXXII.

Hylidæ.

FIG. 1. *Thoropa missiessii*, top of front of skull.
2. *Chorophilus ornatus*, top of skull. Fig. *a*, premaxillary bone; *b*, maxillary; *c*, prefrontal; *d*, ethmoid; *f*, squamosal; *g*, exoccipital; *h*, foramen magnum.
3. *Hypsiboas xerophyllum*, front of top of skull.
4. *Hypsiboas crepitans*, front of top of skull.
5. *Hypsiboas albomarginatus*, front of top of skull; *a*, a thin ossification of basal membrane.
6. *Hypsiboas punctatus*, front of top of skull.
7. *Cincloscopus maximus*, front of top of skull.
8. *Hyla leucomelas*, front of top of skull.
9. *Hyla* ? sp., front of top of skull.
10. *Hyla gratiosa; a*, sternum, front of top of skull.
11. *Hyla americana* (Litoria), front of top of skull.
12. *Hyla freycineti*, front of top of skull.
13. *Hyla hyposticta*, front of top of skull.
14. *Hyla dimolops*, front of top of skull.
15. *Hyla aurea* (Ranoidea), front of top of skull.
16. *Smilisca baudinii*, front of top of skull, with ungual phalanges.

FIG. 17. *Agalychnis moreletii*, front of top of skull.
18. *Phyllomedusa bicolor*, front of top of skull; *a*, sternum.
19. *Hyla carolinensis*, skull from above; *a*, sternum.
20. *Scytopis venulosus*, front of top of skull; 1, ethmoid bone; *a*, another specimen, showing inequalities of surface and posterior outline of ethmoid bone.

PLATE LXXIII.

Hylidæ, *Hemiphractidæ*, *Cystignathidæ*, and *Pelobatidæ*.

21. *Osteocephalus planiceps*, skull from above.
22. *Hypsiboas crepitans*, roof of mouth.
24. *Trachycephalus geographicus*, skull from above; from Steindachner.
25. *Triprion petasatus*, head, side view.
26. *Triprion petasatus*, head, from above.
27. *Triprion petasatus*, interior of mouth.
28. *Cincloscopus maximus*, right manus; u and r, ulna and radius; u and r, ulnar and radial carpals; *c*, central, 1–2–3–4–5 distal carpals, 4 and 5, confluent; 1–5 metacarpals; I supporting a spinous pollex.
29. *Acris gryllus*, right manus, four times natural size.
30. *Hylidæ*, distal phalanges; No. 7, *Trachycephalus marmoratus* anterior and posterior; 8, *Hyla carolinensis*, do.; 9, *Scytopis venulosus*, do.; 10, *Hypsiboas albomarginatus*, do.; 11, *Cincloscopus maximus*, do., posterior attached to penultimate phalange; 12, *Hyla aurea*, do; 13, *Phyllomedusa bicolor*, do.; 14, same, the external ungues of both pedes.
31. *Hemiphractus scutatus*, head from above, from Boulenger.
32. *Scaphiopus holbrookii*, right manus; lettering as in Fig. 28.
33. *Mixophyes fasciolatus*, right manus, lacking the phalanges; letters as in Fig. 28.
34. *Leptodactylus pentadactylus*, left manus, the male showing process of second metacarpal, which is wanting in the female (♀); lettering as in Fig. 28.

PLATE LXXIV.

Embracing *Hemisidæ*, *Brevicipitidæ*, *Engystomidæ*, *Phryniscidæ*, and *Dendrobatidæ*.

FIG. 1. *Hemisus guttatum*, skull, from above.
1*a*. *Hemisus guttatum*, skull, from left side, exhibiting the suprascapulo-proötic articulation, and the small freely-moving suspensorium.
2. *Hemisus guttatum*, sternum; from Boulenger.
3. *Breviceps gibbosus*; *a*, anterior part of top of skull from above; *b*, end of muzzle from front, displaying lateral premaxillaries between the premaxillaries, the maxillaries, and the nares; *c*, vertebral column, less the first and the sacrum, from below; *d*, last lumbar vertebra, anterior extremity from left side; *e*, last lumbar vertebra, anterior extremity, from front.
4. *Phrynomantis bifasciatus*, front of top of skull.
5. *Phrynomantis bifasciatus*, symphysis mandibuli, from above.
6. *Phrynomantis bifasciatus*, from front.
7. *Microhyla achatina*, top of front, and anterior end of frontoparietal, showing dotted outline of ethmoid.
8. *Callula balteata*, top of front, from above.
9. *Engystoma microps*, top of front, from above.
10. *Cacopus systoma*, top of front, from above, with profile of prefrontal bones.
11. *Diplopelma ornatum*, top of front, one-half the frontoparietal removed to show the ethmoid.
12. *Diplopelma ornatum*, symphysis mandibuli.
13. *Engystomidae* (name mislaid).
14. *Hypopachus variolosus*, top of skull; *a*, sternum.
15. *Stereocyclops incrassatus*, top of skull, *a*, sternum.

FIG. 16. *Atelopus flavescens*, top of front and ethmoid.
17. *Atelopus?* sp., top of front, ethmoid, and profile of prefrontal bone.
18. *Phryniscus varius*, top of front, with profile of prefrontal bone.
19. *Phryniscus? lævis*, top of front, ethmoid, and profile of prefrontal bone.
20. *Rhinoderma darwini*, top of front and profile of prefrontal bone.
21. *Dendrobates tinctorius*, top of front and anterior extremity of parasphenoid bone.
22. Ungual phalanges of—No. 15, *Dendrobates tinctorius;* 16–17, *Atelopus flavescens;* 18, *Callula picta;* 22, *Callula balteata.*
23. *Cacopus systoma*, sternum, from Boulenger.
24. *Dyscophus antongilii*, sternum, from Boulenger.

PLATE LXXV.

Ranidæ.

FIG. 1. *Phyllobates bicolor*, part of skull.
2. *Prostherapis brunneus*, skull and sternum.
3. *Hylambates marmoratus*, front of skull, above.
4. *Cassina senegalensis*, front of skull, above; with the anterior extremity of the frontoparietal bones of an older individual.
5. *Hyperolius madagascariensis*, front of skull, above.
6. *Cornufer dorsalis*, front of top of skull and ethmoid.
7. *Phrynobatrachus natalensis*, front of top of skull.
8. *Staurois natator*, front of top of skull.
9. *Ranula chrysoprasina*, front of top of skull; *a*, sternum of do.
10. *Rana junghuhnii*, front of top of skull.
11. *Rana malabarica*, front of top of skull.
12. *Rana erythræa*, front of top of skull; young.
13. *Rana erythræa*, front of top of skull; medium.
14. *Rana erythræa*, front of top of skull; large.
15. *Rana mascariensis*, front of top of skull.
16. *Rana fasciata*, front of top of skull.
17. *Rana oxyrhyncha*, front of top of skull.
18. *Rana breviceps*, front of top of skull; one a superior, the other an antero-superior view.
*a*9. *Rana clamata*, front of top of skull.
20. *Rana agilis*, top of head from front; adult.
21. *Rana agilis*, top of head from front; young.
22. *Rana cyanophlyctis*, top of head from front; young.
23. *Rana tigrina*, top of head from front; young.
24. *Rana tigrina*, top of head from front; adult, the anterior part of the frontoparietals removed, showing the form of the ethmoid and the cartilage of its superior face, the accompanying figure representing the ethmoid with the cartilage removed.
25. *Rana leschenaultii*, young; front of top of skull.
26. *Rana occipitalis*, front of top of skull.
27. *Rana hexadactyla*, front of top of skull.
28. *Rana fuscigula*, front of top of skull.
29. *Rhacophorus reinwardtii*, front of top of skull.
30. *Chiromantis xerampelina*, front of top of skull.
31. *Polypedates maculatus*, top of head.
32. *Oxyglossus lima*, top of front of skull.
33. Ungual phalanges of Ranidæ. Fig. 1, *Rana erythræa*, posterior foot; 2, *Polypedates maculatus*, anterior foot; 3, do., anterior and posterior feet; 4, *Rhacophorus reinwardtii*, anterior and posterior feet; 19, *Rana malabarica*, both feet; 20, *R. temporaria*, both feet 21, *R. clamata*, both feet; 22, *R. fuscigula*, both feet.

PLATE LXXVI.

Hyoid apparatus of Anura, mostly enlarged. Figures copied from Parker's Structure and Development of the Skull in the Batrachia, except Fig. 18 which is is original, and Figs. 2, 3, 5, 6, and 7, which are from Dugés Osteologie et Myologie des Batraciens, corrected by comparison with Parker *l. c.*

FIG 1. *Xenopus capensis*, S. Africa.
2. *Bombinator igneus*, Europe.
3. *Alytes obstetricans*, Europe.
4. *Xenophrys monticola*, India.
5. *Pelobates fuscus*, Europe.
6. *Pelodytes punctatus*, Europe.
7. *Bufo vulgaris*, Europe.
8. *Phyllomedusa bicolor*, S. America.
9. *Hyla ewingii*, Australia.
10. *Cophœus marmoratus*, S. America.
11. *Cystignathus typhonius*, S. America.
12. *Atelopus varius*, Costa Rica.
13. *Callula pulchra*, Farther India.
14. *Engystoma carolinense*, N. America.
15. *Dendrobates tinctorius*, S. America.
16. *Rhacophorus maximus*, India.
17. *Rana esculenta*, Europe.
18. *Hemisus guttatus*, Natal.

PLATE LXXVII.

Superficial and deep muscles of the manus and pes of three species of Anuras.

FIGS. 1, 2. *Leptodactylus pentadactylus*, manus, male.
3, 4. *Leptodactylus pentadactylus*, manus, female.
5, 6, 7. *Scytopis venulosus*, pes.
8, 9, 10, 11. *Rana esculenta*, pes.

The lettering in Figs. 1–4 is identical with that used in Dugés Osteologie et Myologie des Batraciens.

No. 87, Cubito-metacarpal; 88, subluno-metacarpal of the index; 89, metacarpo-metacarpal of the index; 95, humero-subdigital; 96, cubito-radio-subphalangeal of the index; 120, subluno-phalangettal of the index; 121, submetacarpo-phalango-phalangettal of the index. In Figs. 5 and 8 are displayed the superficial flexors of the digits. In 6, 7, 9, 10 and 11, the deeper muscles of the phalanges and metatarsals are exbibited in the numbers from 7 to 21. Nos. 13 and 22 are the second and third intermetatarsals of Dugés.

PLATE LXXVIII.

Embryology of *Hyla pickeringii* Holbr., and *Hyla ? versicolor* Lec.; from drawings by Prof. S. F. Baird.

FIGS. 1–19. *Hyla pickeringii.*
1. Egg with germinal vesicle; first day after laying, May 15, 9 a. m. Figure *a* natural size.
2. The same, May 16, 9 a. m.; from above.
3. The same, May 16, 9 a. m.; from below, showing germinal area.
4. The same in profile.
5. First appearance of embryo in egg laid about the evening of May 14.

FIGS. 1–19. *Hyla pickeringii*—Continued.

6. Side view of the same.
7. A more advanced embryo.
8. Side view of the same.
9. Embryo still further advanced, May 16, 4 p. m. Fig. *a*, side view of the same.
10. Vitellus of elongate form, with brown polygonal spots arranging themselves in meridians, May 16, 4 p. m. Laid about 10 a. m., May 15.
11. Embryo on May 17, 10 a. m.; rotation commenced; Fig. *a*, profile.
12. Embryo May 17, 11 a. m.; *a*, profile.
13. Embryo May 17, 4 p. m., straightened out.
14. Embryo May 17, 4 p. m., profile.
15. Embryo May 17, 5 p. m., profile enlarged, displaying ciliary movements.
16. The same; head from front.
17. May 18, 9 a. m., liberated artificially and swimming.
18. The same; front and below.
19. May 18, 3.30 p. m.
20. Tadpole, anterior part.
21. Eye of same in profile.
22. Brain and spinal cord of tadpole.

23–26. *Hyla ? versicolor.*

23. Embryo in albumen, April 9.
24. Embryo just before liberation.
25. Embryo just after liberation; branchial circulation distinct.
26. Head of the same from below; diagram.

PLATE LXXIX.

Development of the three anterior inferior cranial arches of the genus *Rana*; much enlarged. From W. K. Parker.

The arches are: the trabecular (in dotted outline), the mandibular, and the ceratohyal. The successive stages of the ossicula auditus are exhibited also. For explanations of details, see Plates XLVIII to L.

PLATE LXXX (cancelled).

PLATE LXXXI (cancelled).

PLATE LXXXII (cancelled).

PLATE LXXXIII.

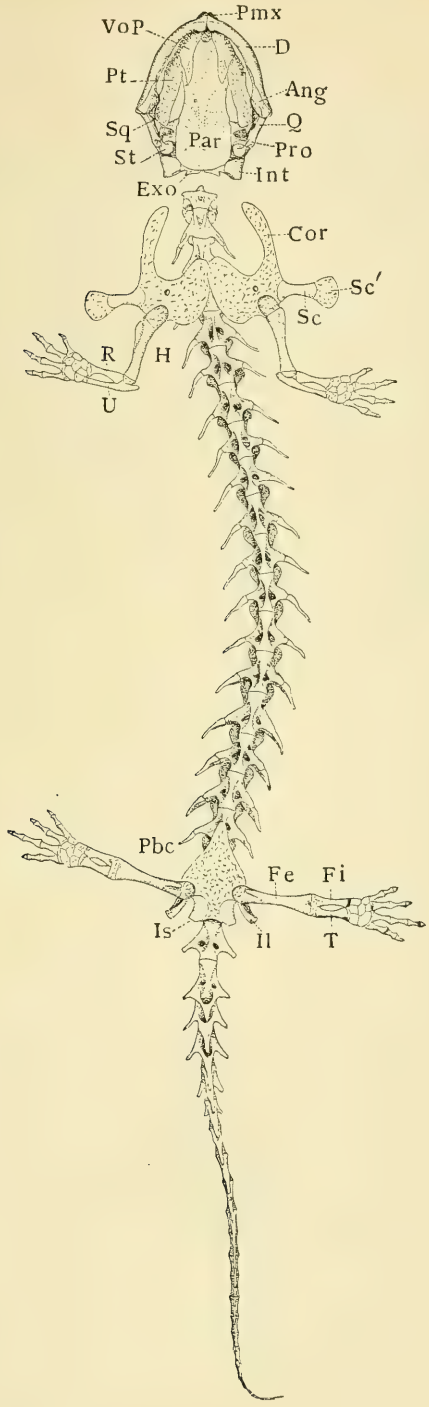
FIG. 1. *Hyla andersonii* Baird; natural size.
2. *Hyla gratiosa* Le Conte; natural size.
3. Do.; mouth, within.
4. Do.; hand.
5. Do.; foot.

PLATE LXXXIV (cancelled).

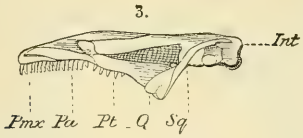
PLATE LXXXV (cancelled).

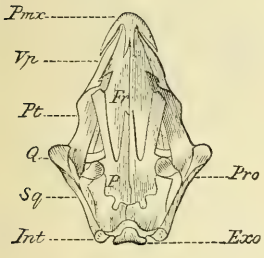
PLATE LXXXVI.

Rana septentrionalis Baird, var. *sinuata* Baird; natural size.



NECTURUS MACULATUS.





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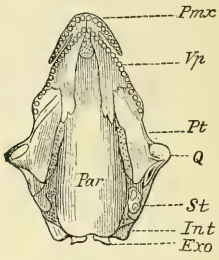

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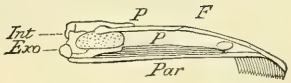

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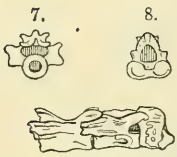
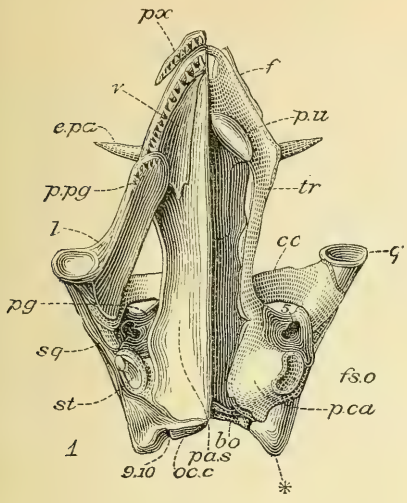
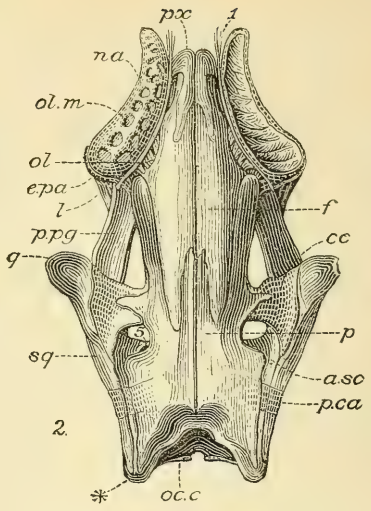


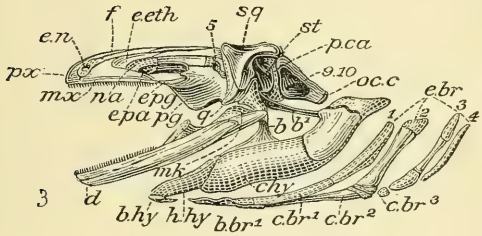
7. 8. 9.

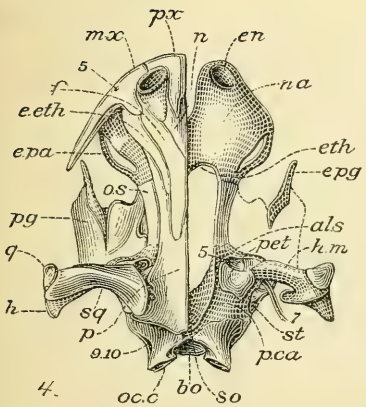
6.

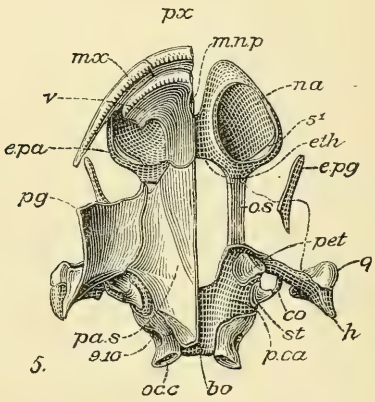
NECTURUS MACULATUS.



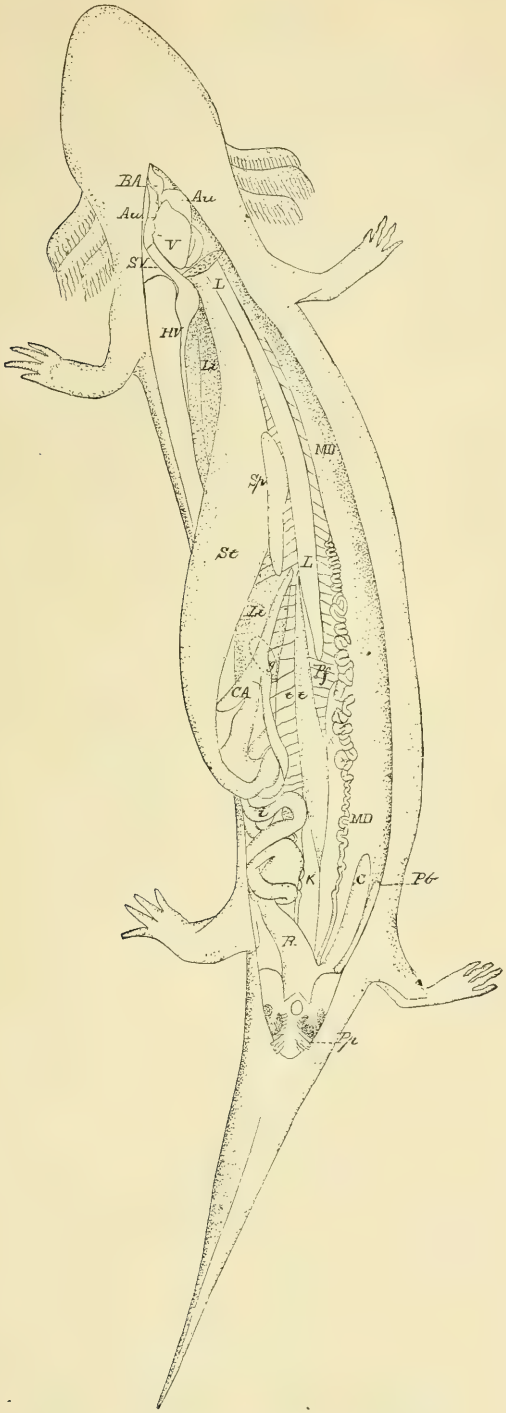




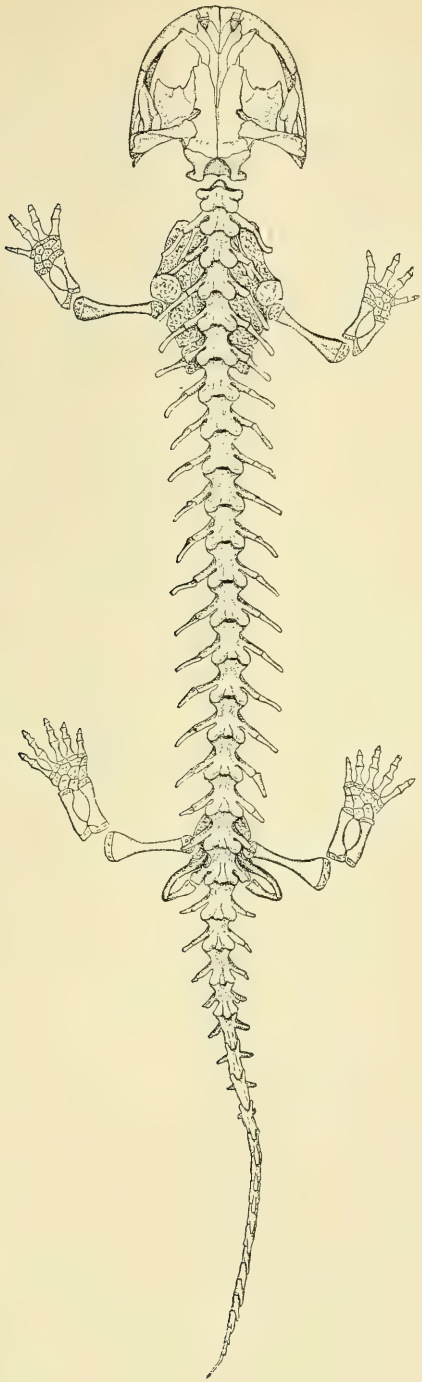




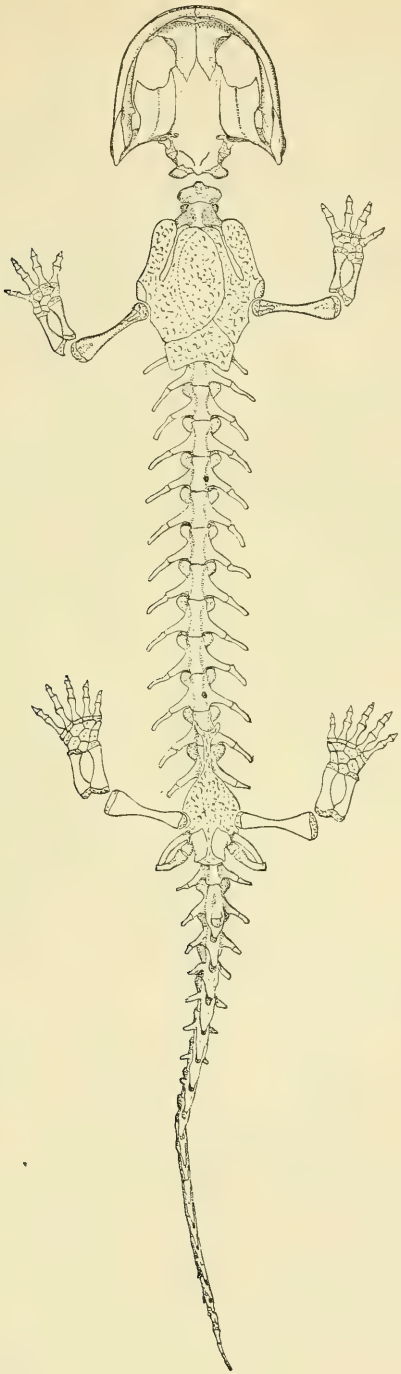
NECTURUS AND CRYPTOBRANCHUS.



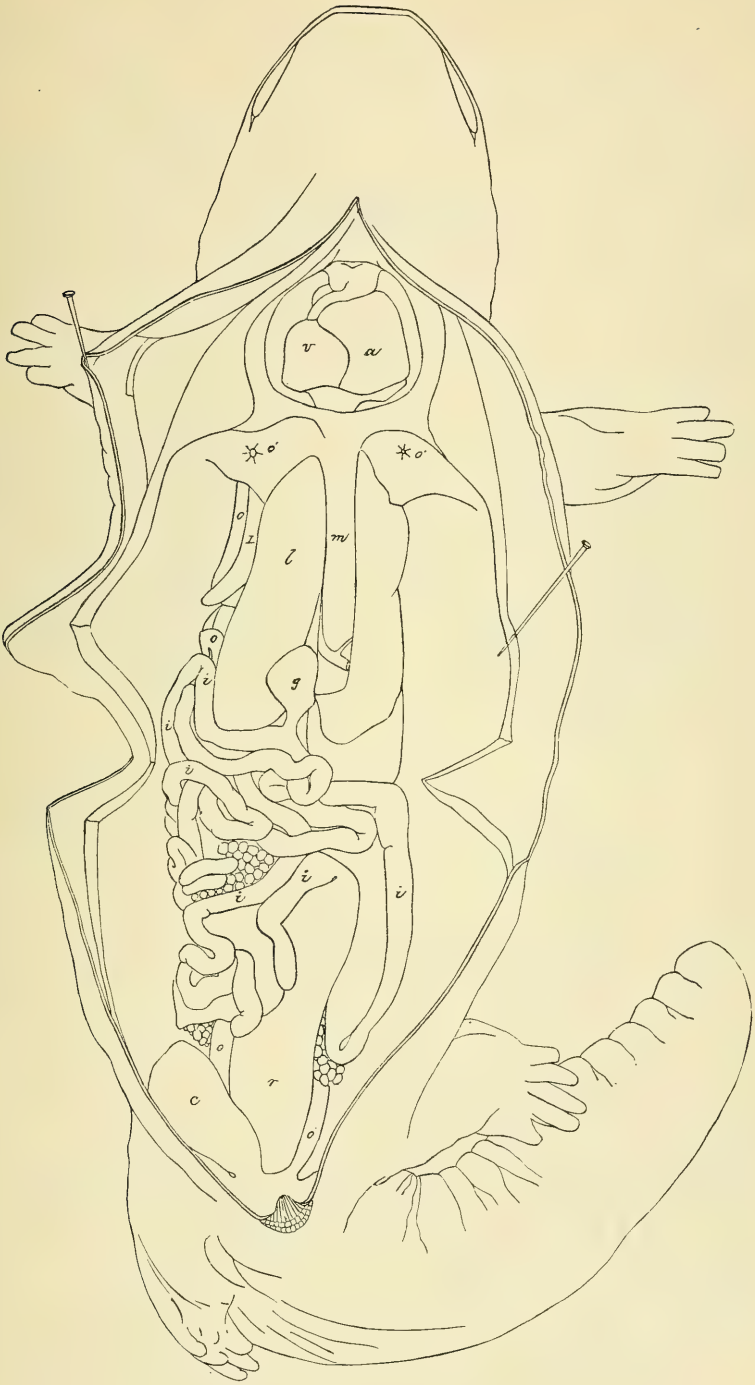
NECTURUS MACULATUS.



CRYPTOBRANCHUS ALLEGHENIENSIS.



CRYPTOBRANCHUS ALLEGHENIENSIS.



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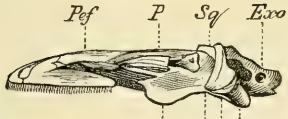

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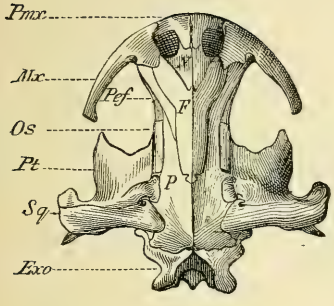

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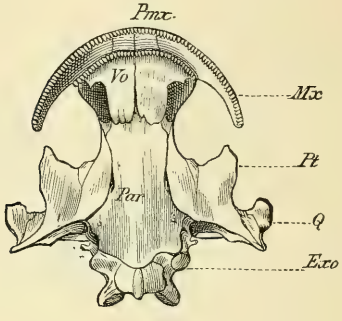

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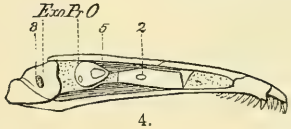

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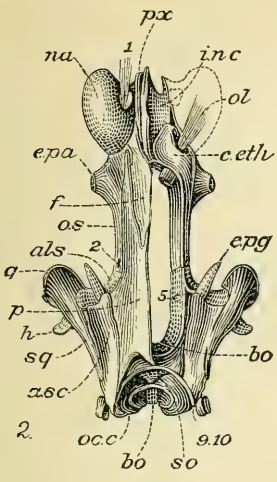
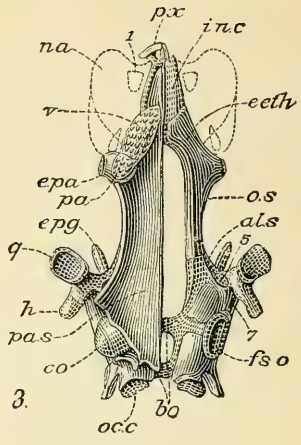
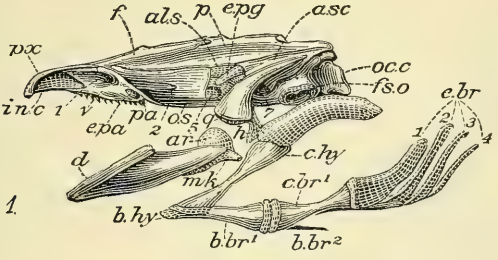
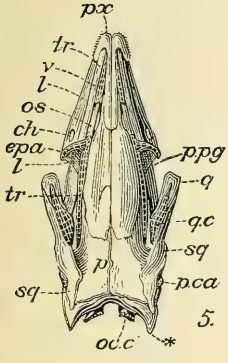
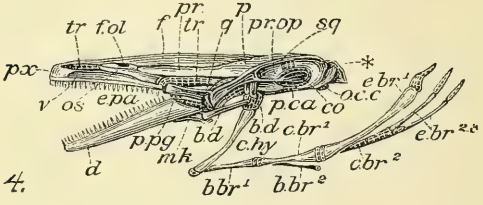
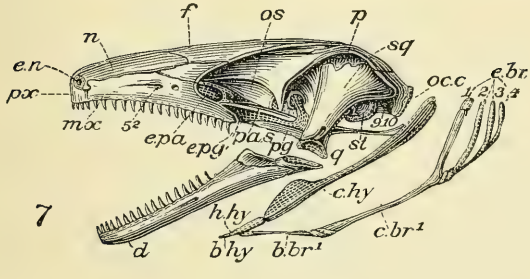


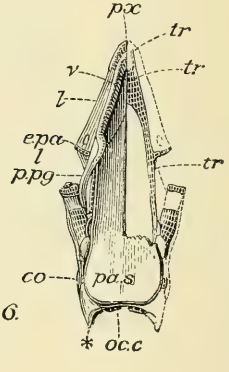




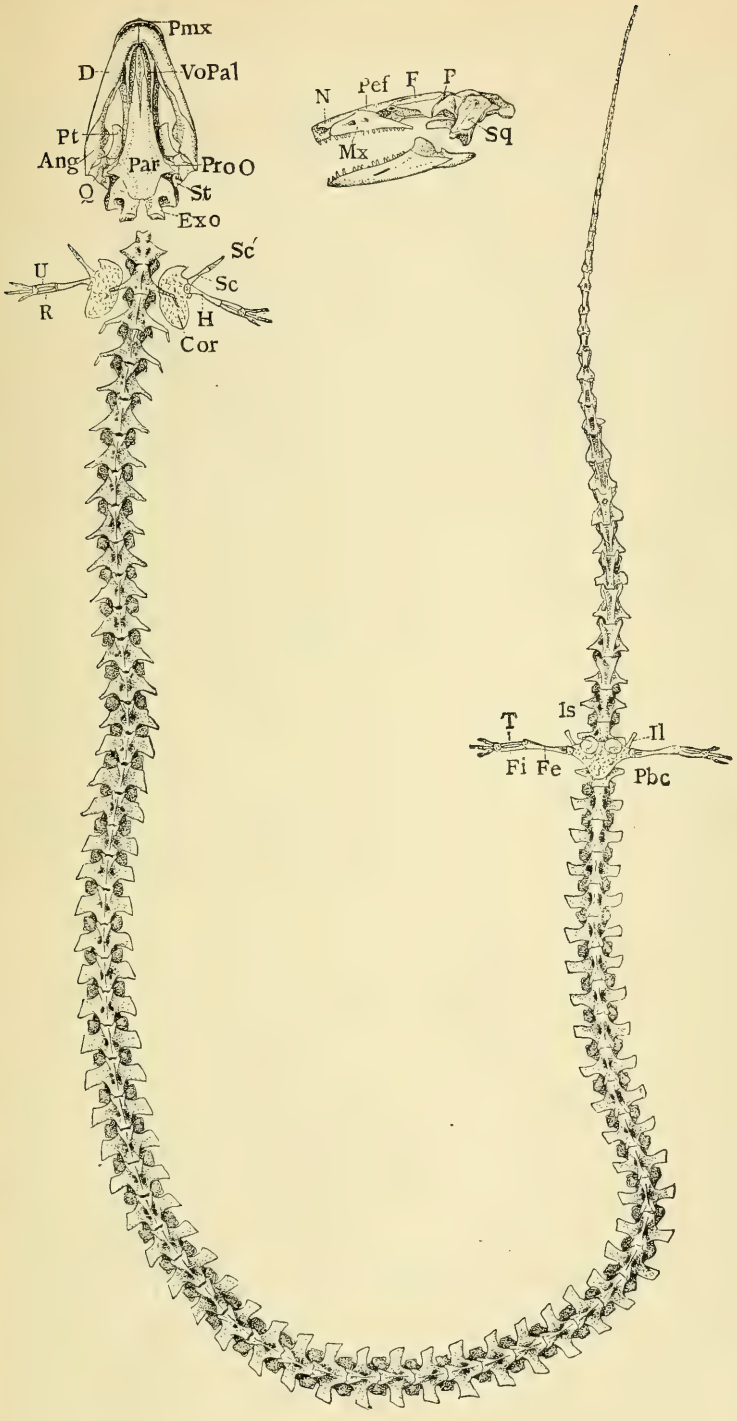








SIREN, PROTEUS, AND AMPHIUMA.



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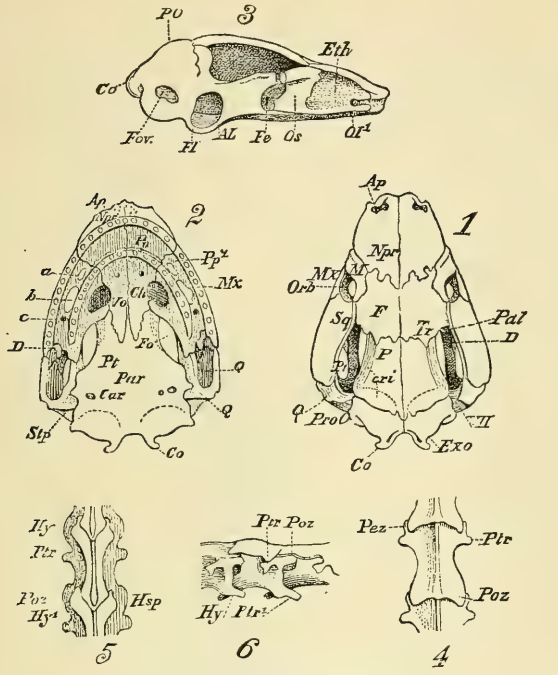

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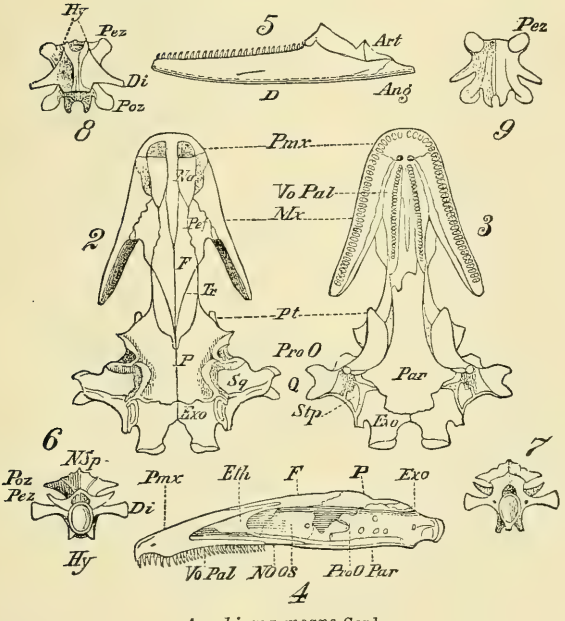

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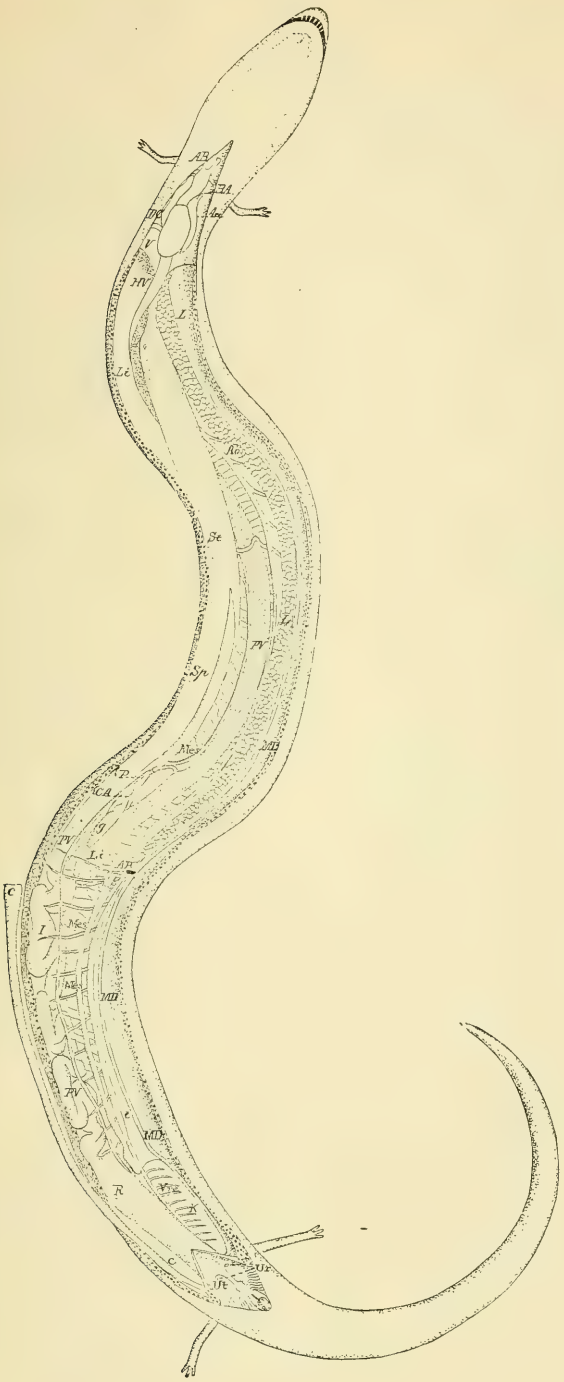

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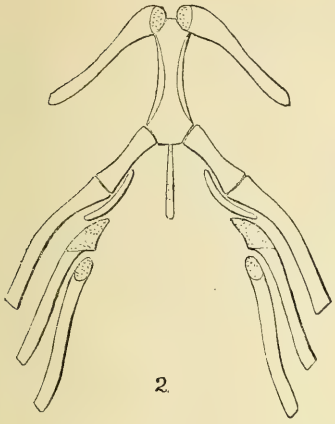

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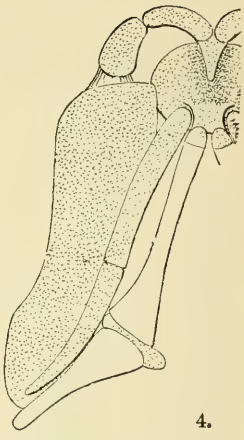

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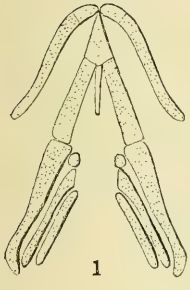

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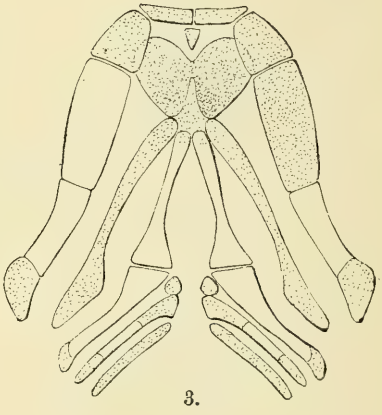

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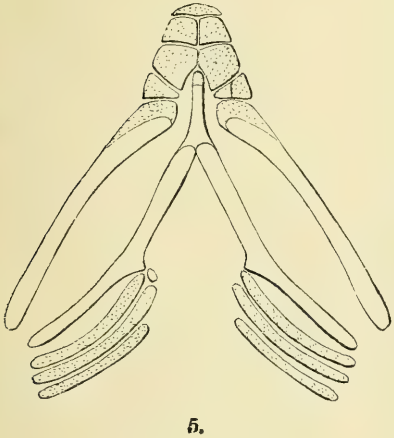

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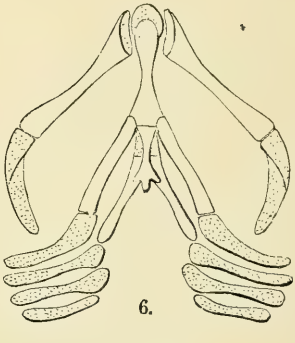

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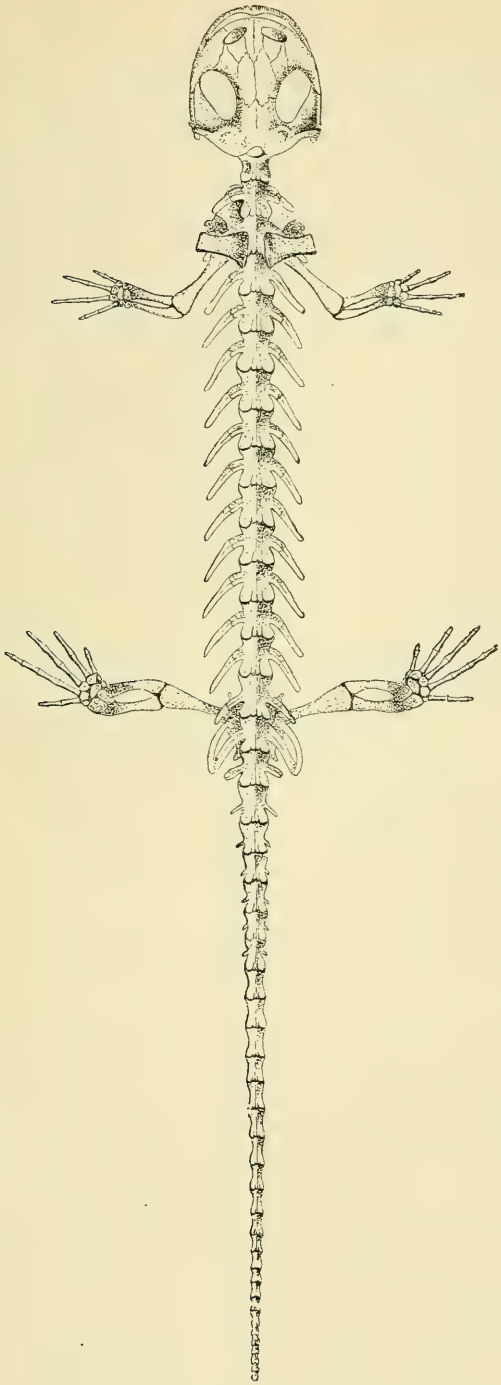

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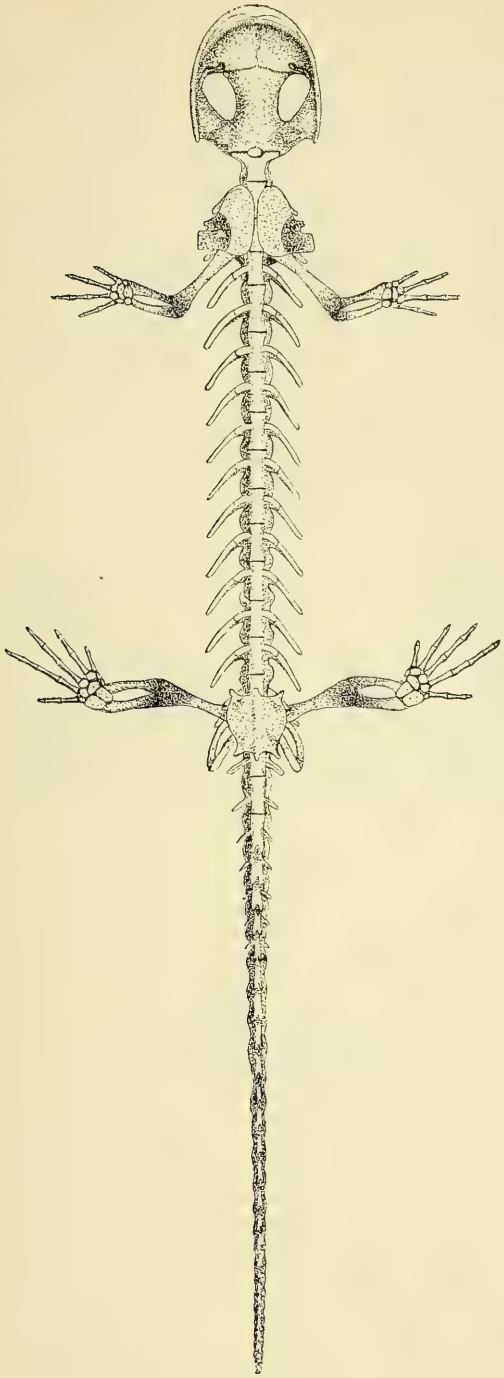

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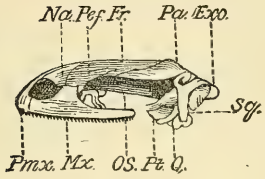

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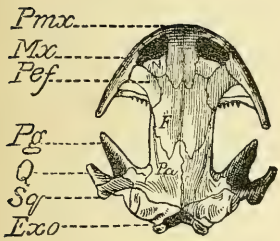

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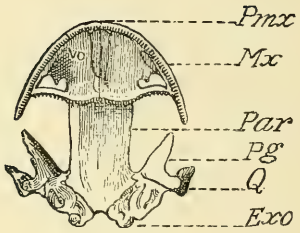

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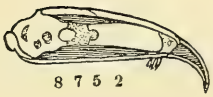

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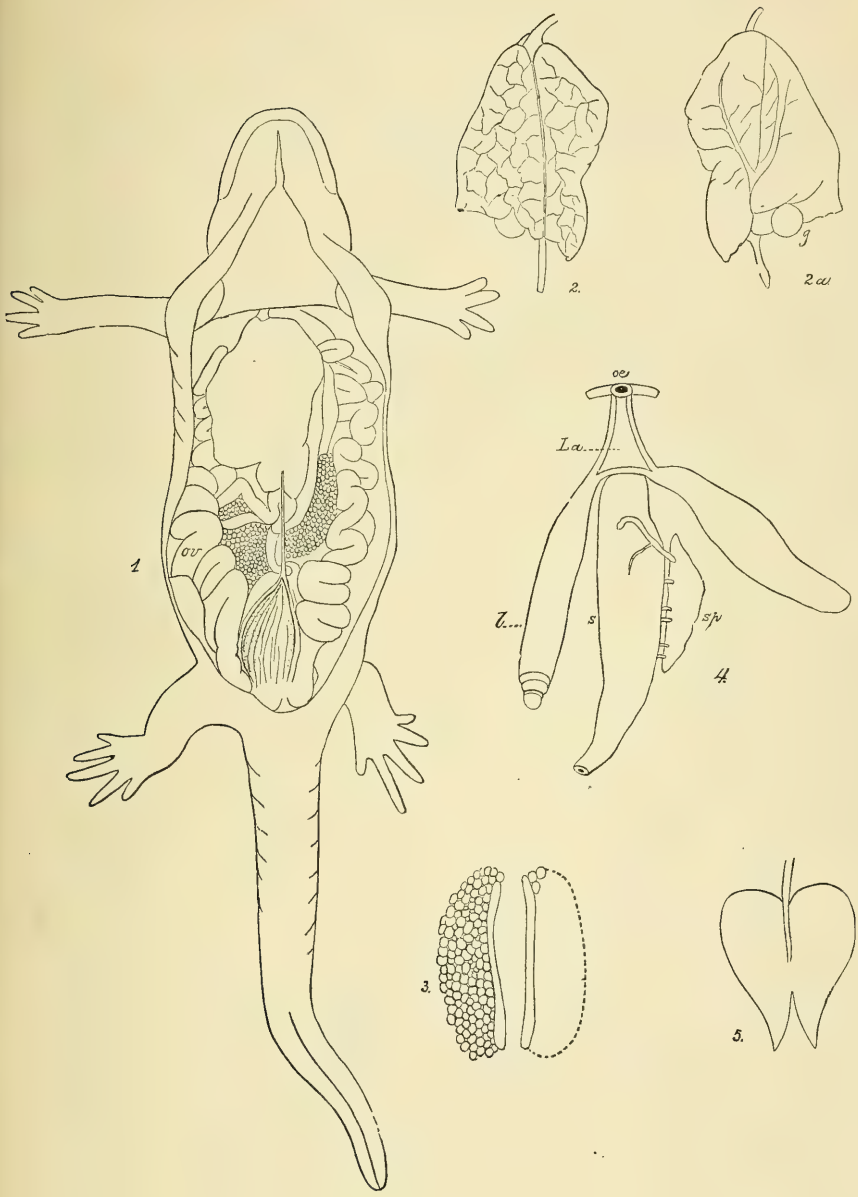

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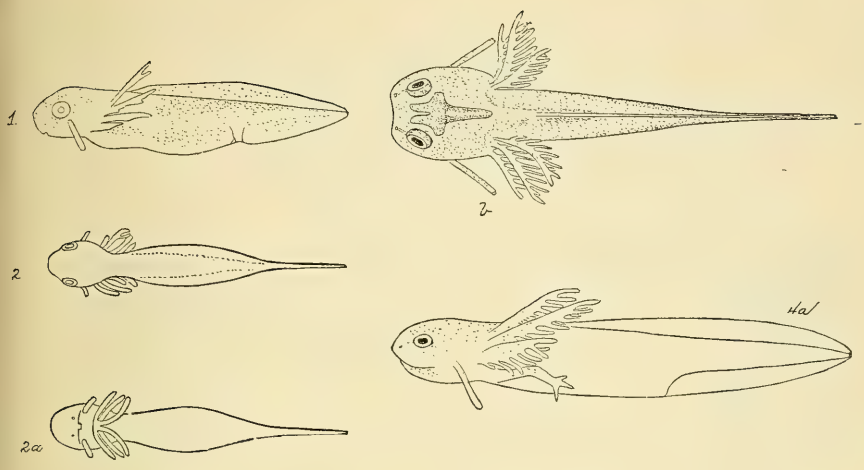

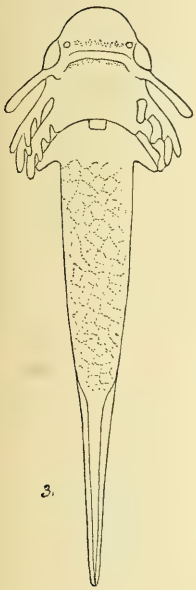

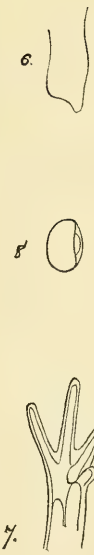

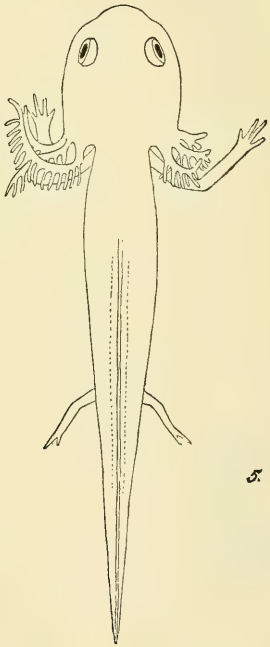

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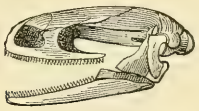

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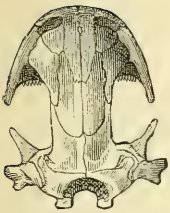

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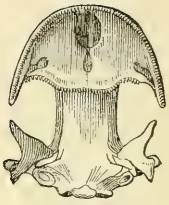

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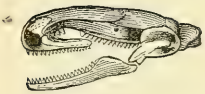

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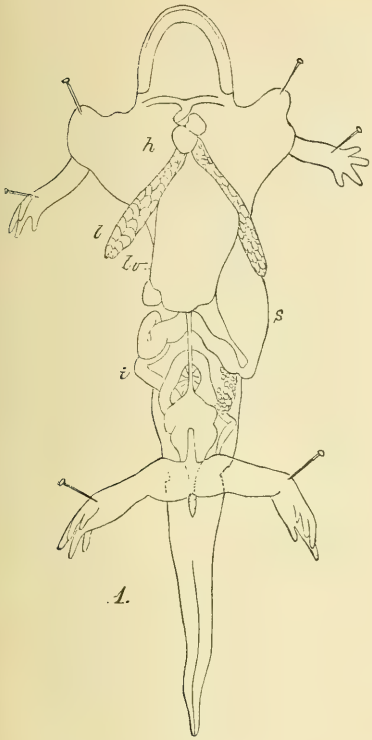

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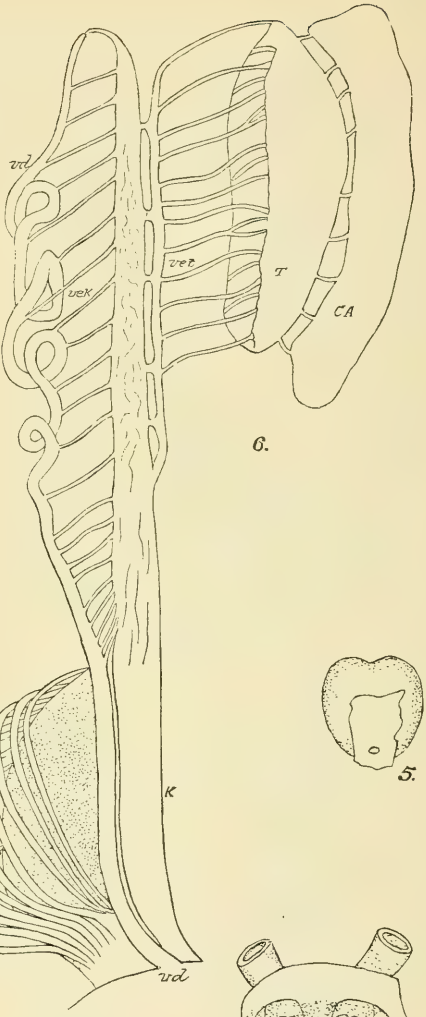

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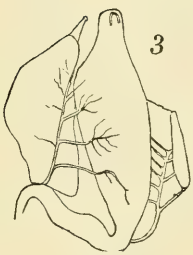

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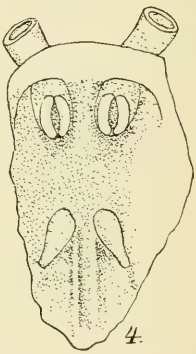

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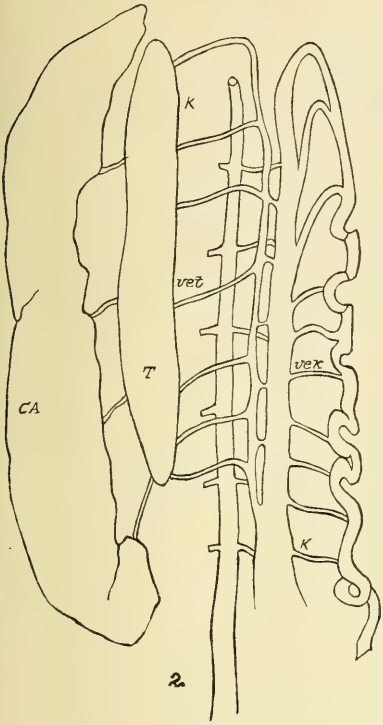

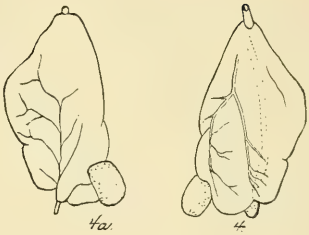

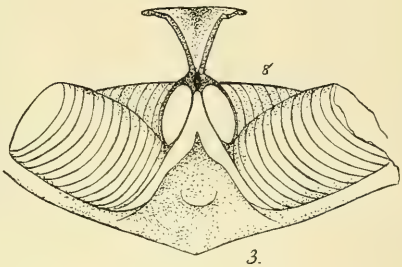

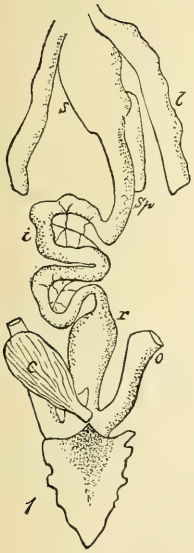

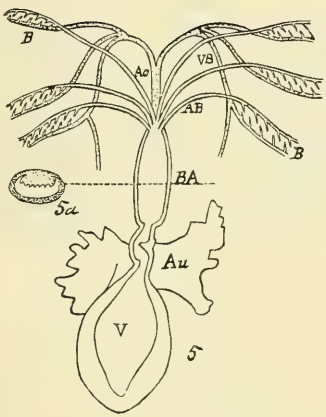

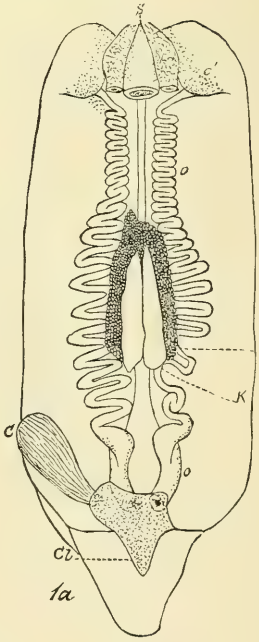

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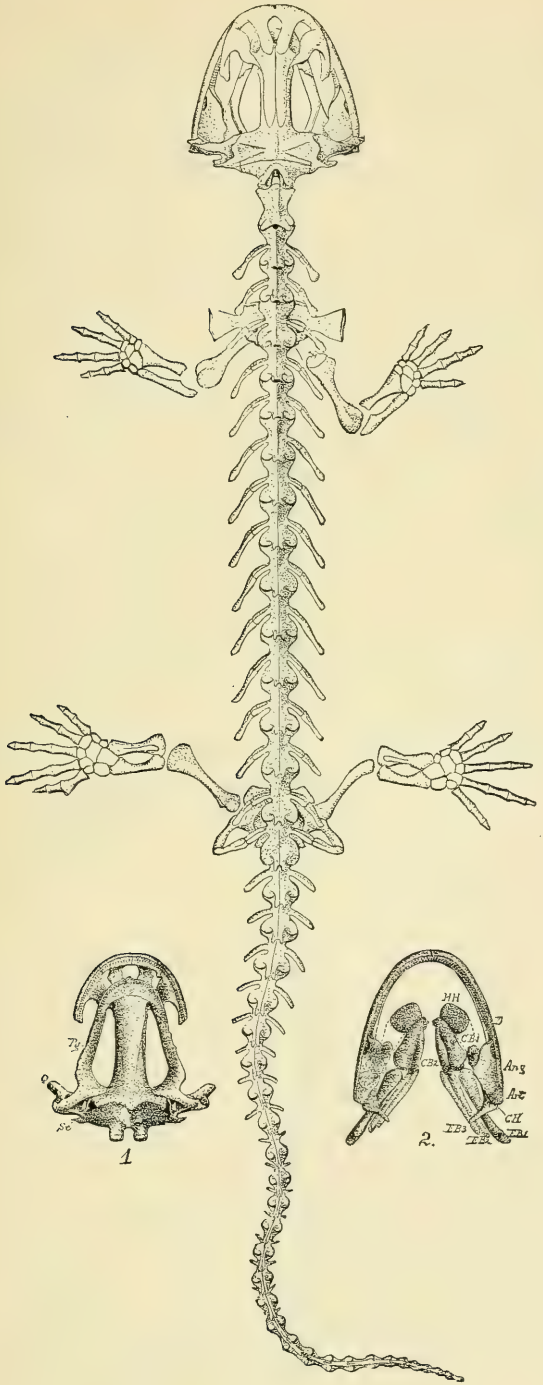

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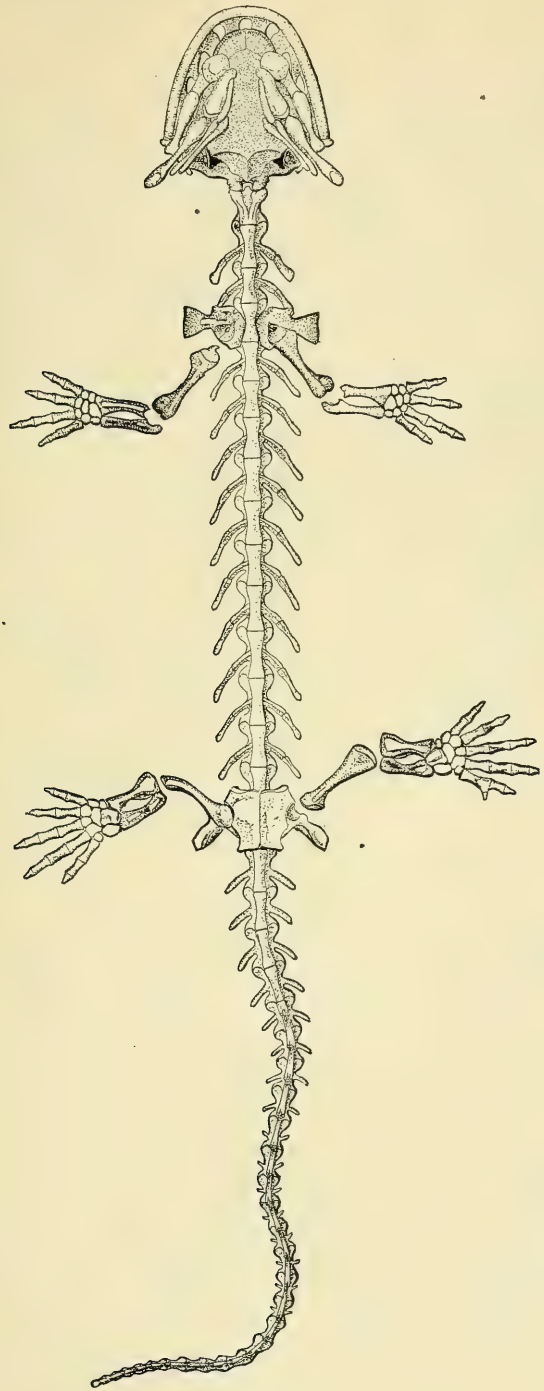

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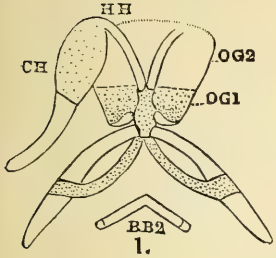

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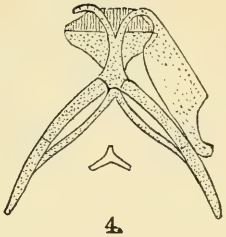
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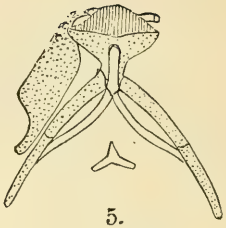
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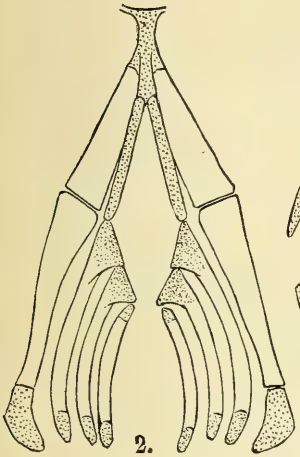
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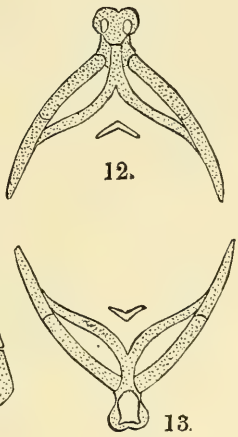

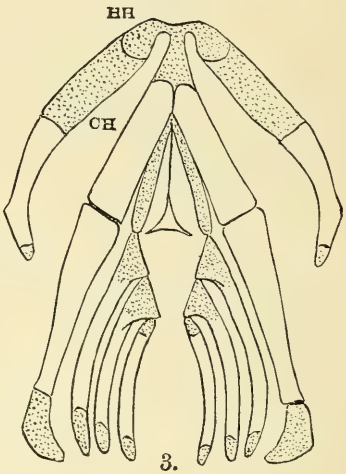

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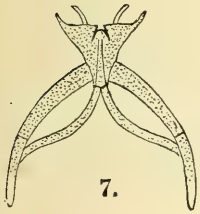
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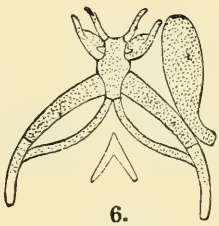
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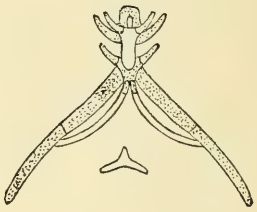
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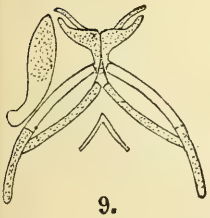
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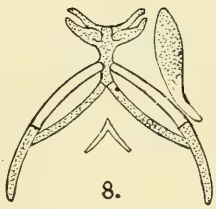
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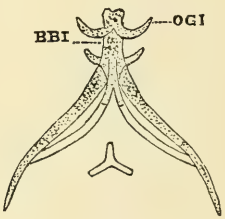

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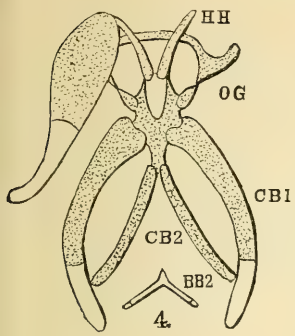
HYOID ARCHES OF AMBLYSTOMIDÆ.



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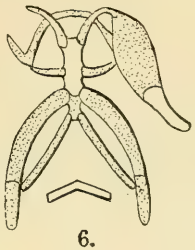
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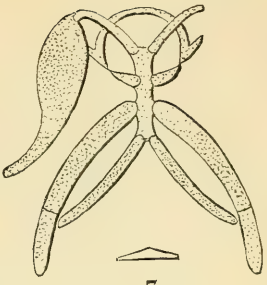
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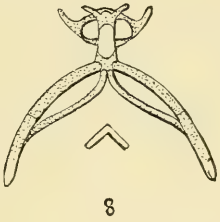
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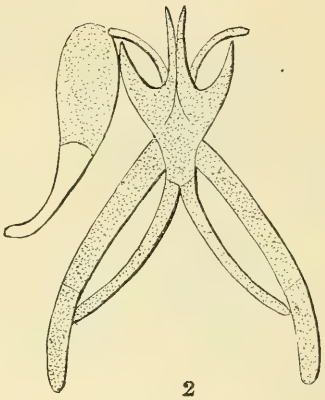
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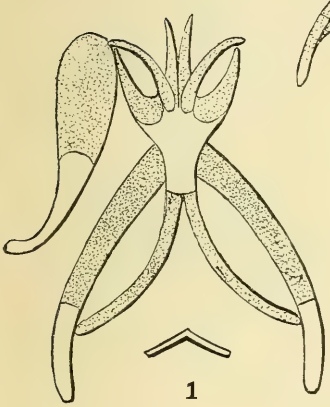
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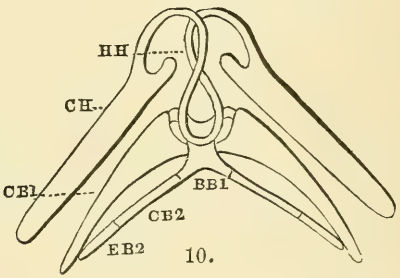

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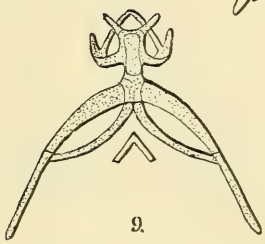
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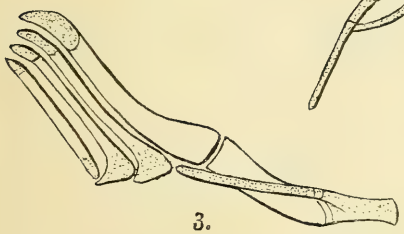
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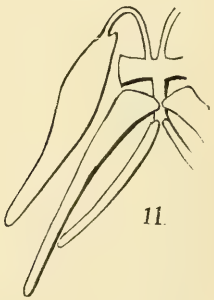
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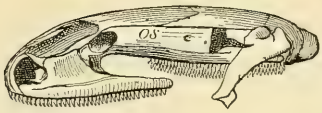
HYOID ARCHES OF AMBLYSTOMIDÆ AND HYNOBIIDÆ.



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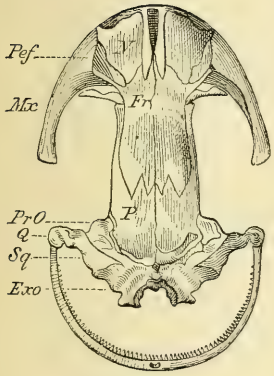

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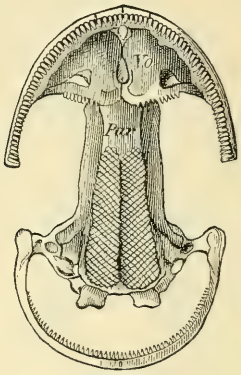

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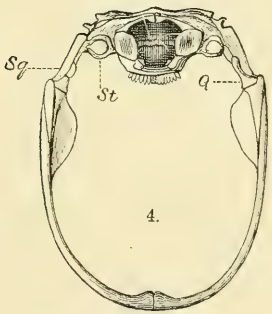

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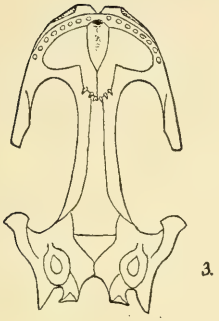

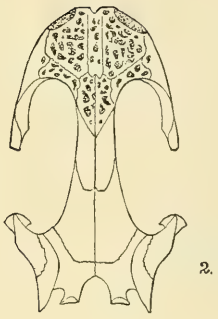

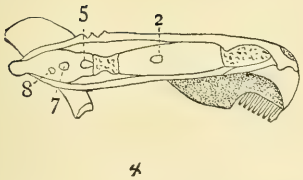

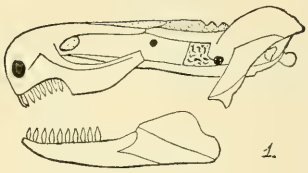

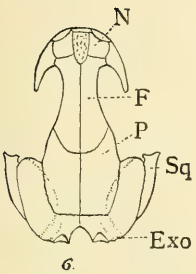

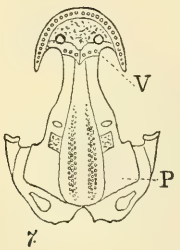

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3.

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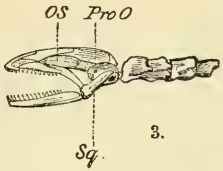
5.

SPELERPES LONGICAUDUS AND S. BILINEATUS.



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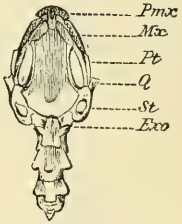

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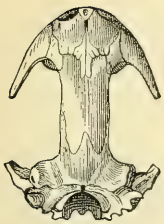

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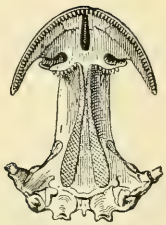

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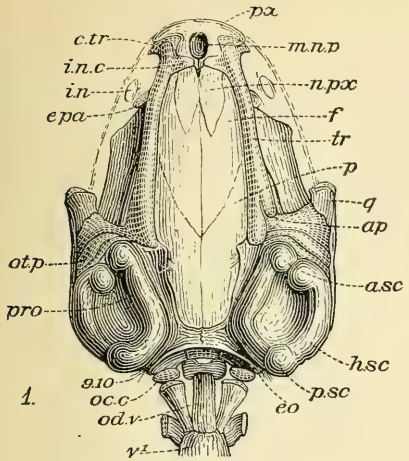

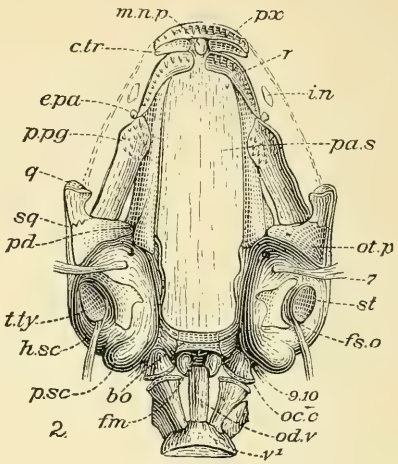

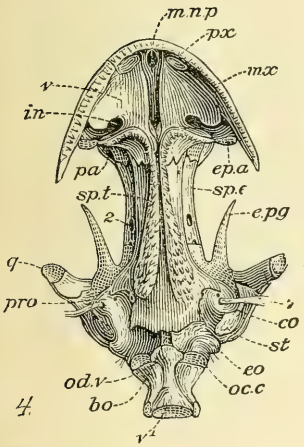

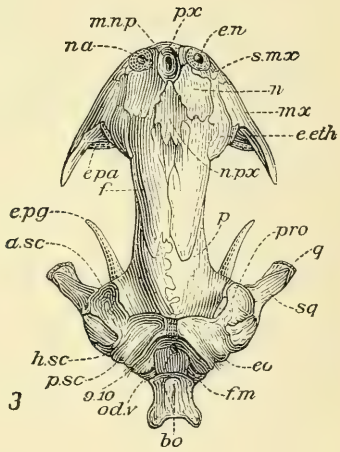

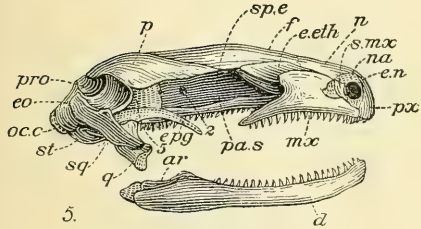

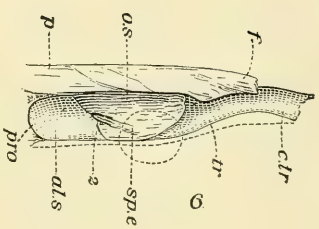

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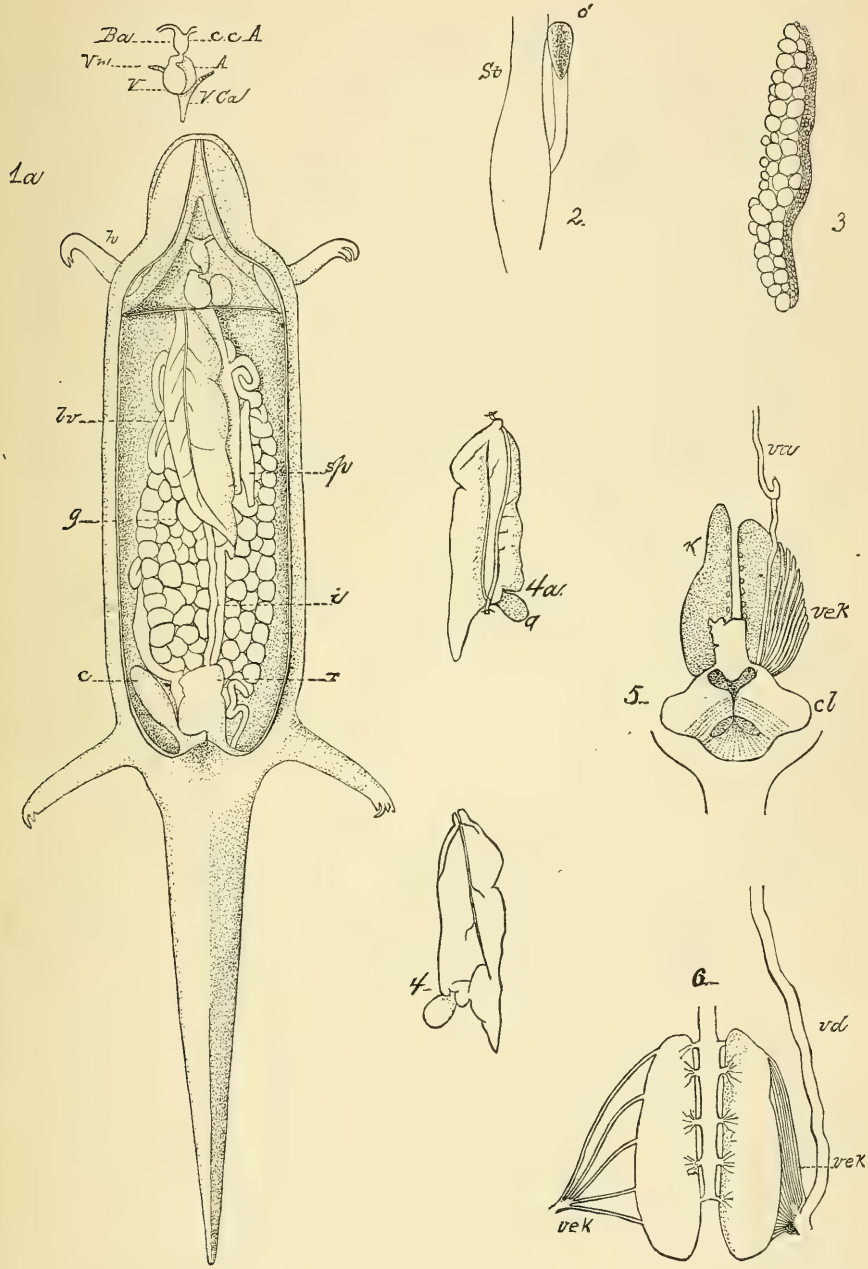

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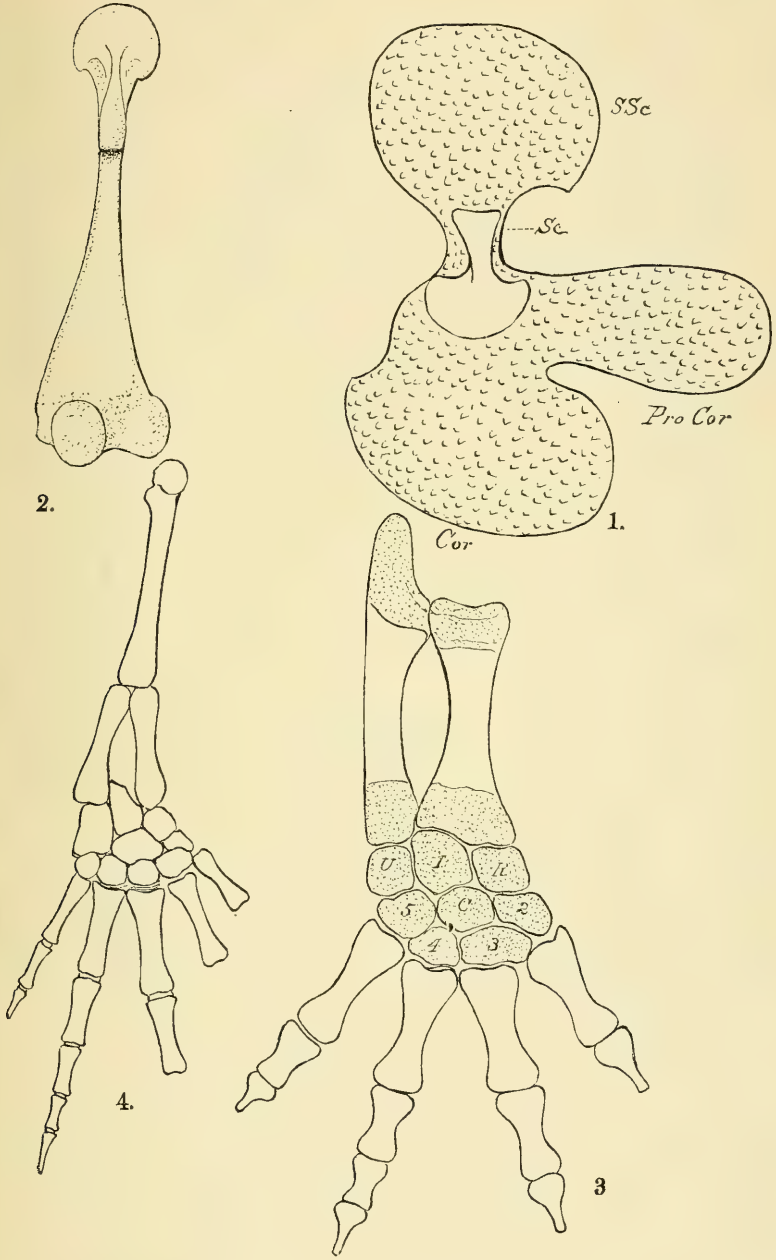

SPELERPES AND AMBLYSTOMA.

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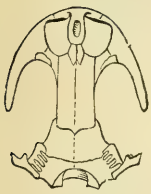

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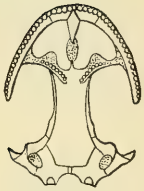

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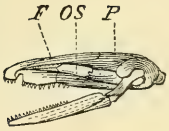

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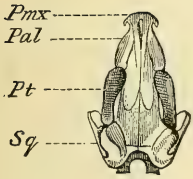

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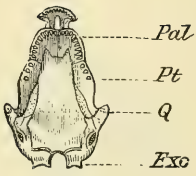

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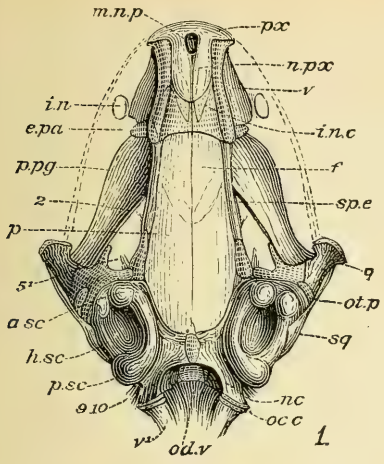

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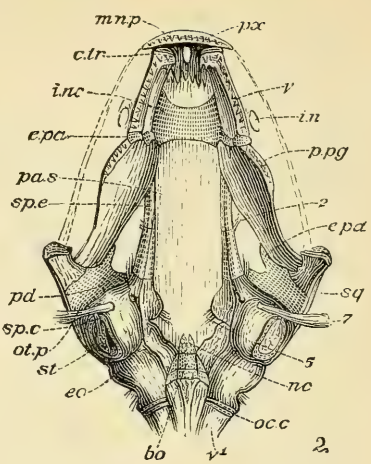

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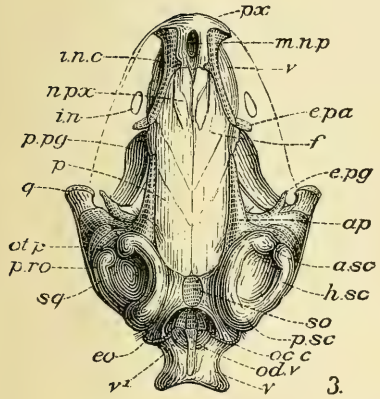

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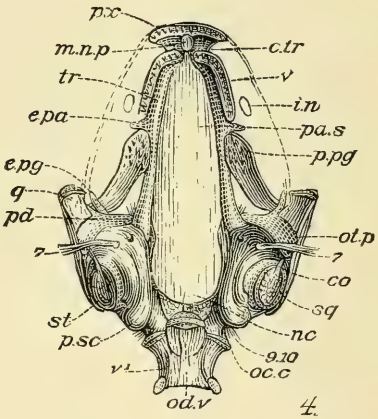

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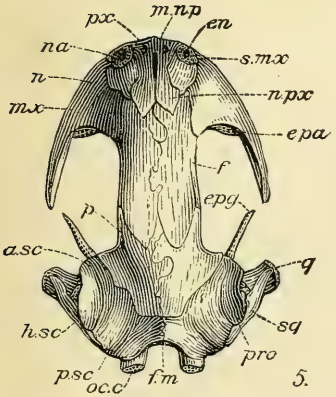

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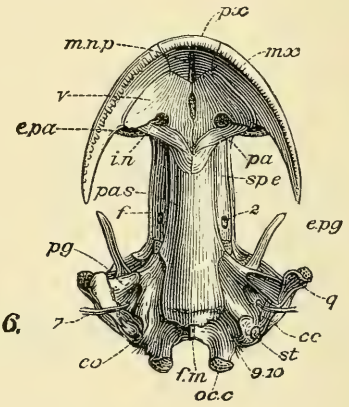

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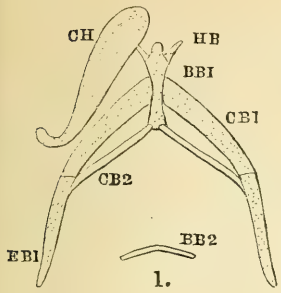

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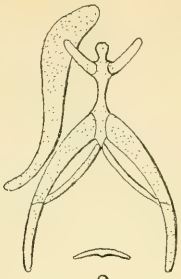
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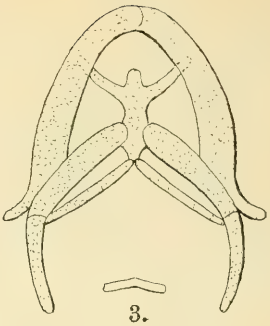
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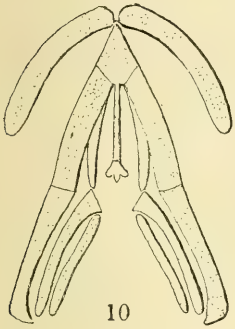
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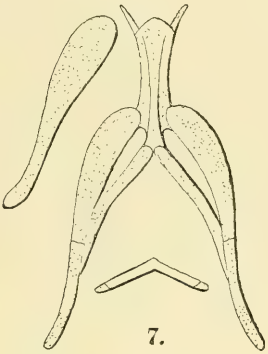
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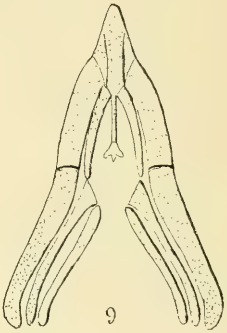
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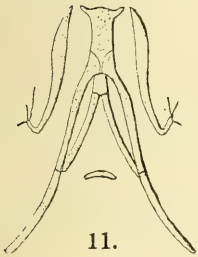
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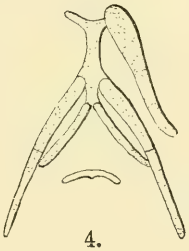
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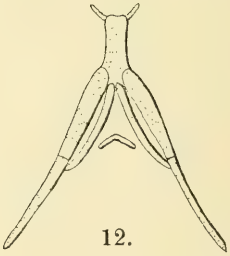
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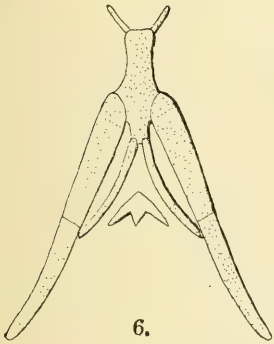
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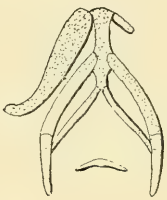
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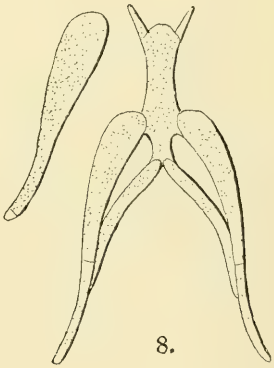
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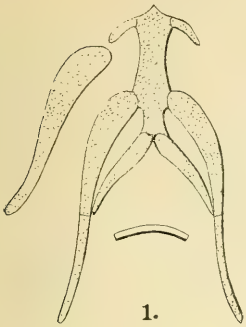
HYOID ARCHES OF PLETHODONTIDÆ.



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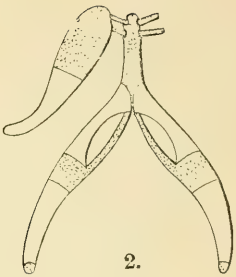

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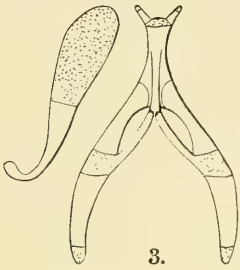

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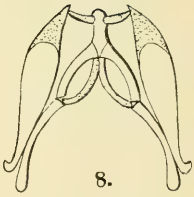

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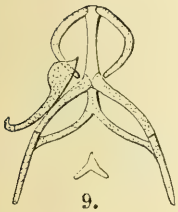

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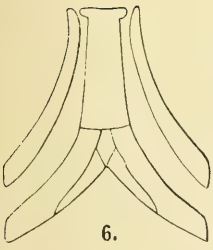

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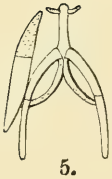

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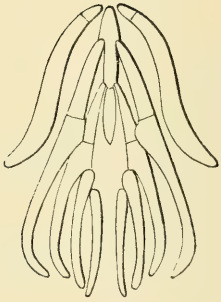

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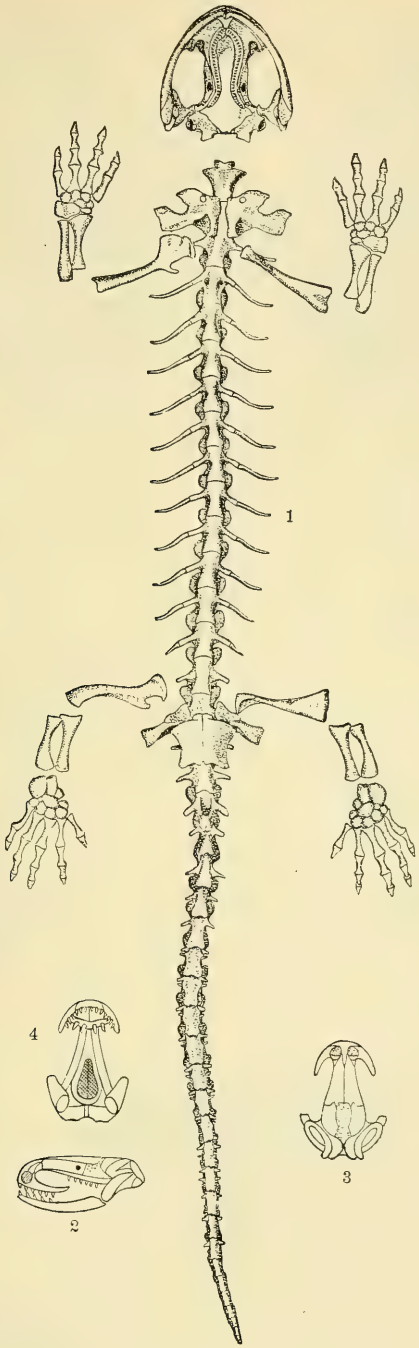

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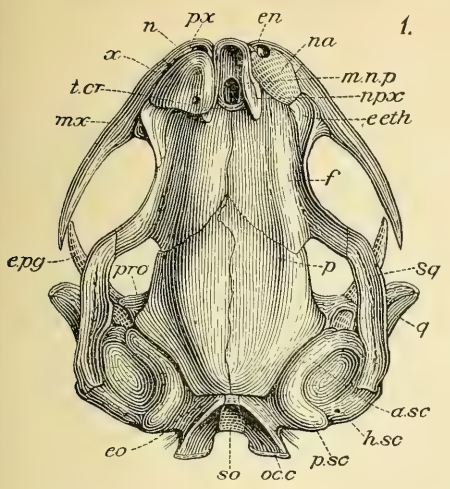
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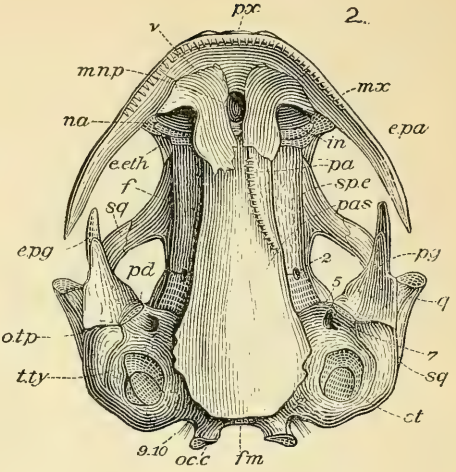
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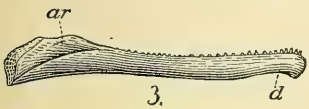
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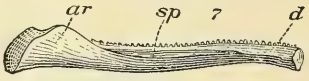
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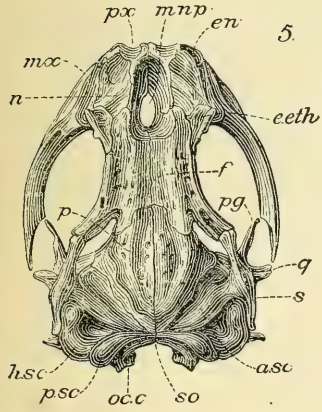
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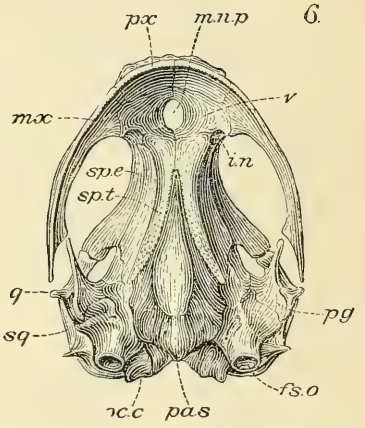
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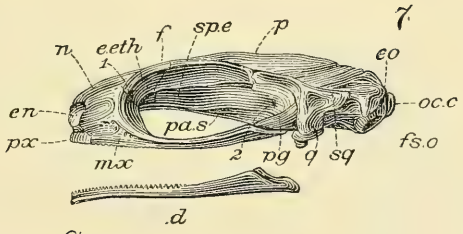
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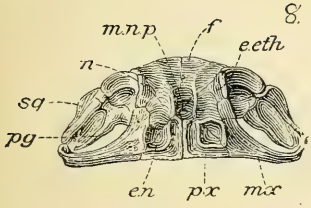
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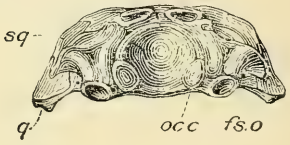
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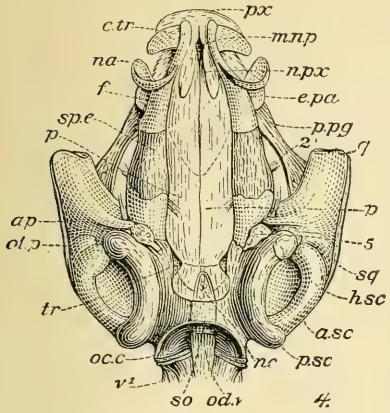

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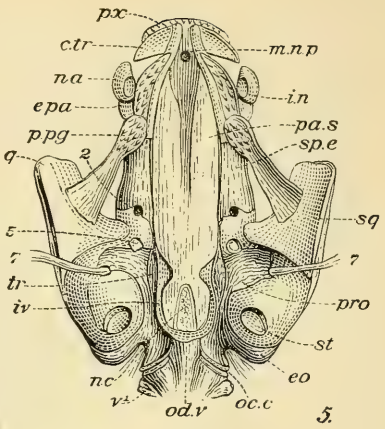

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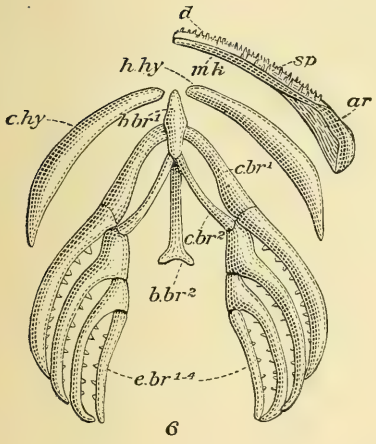

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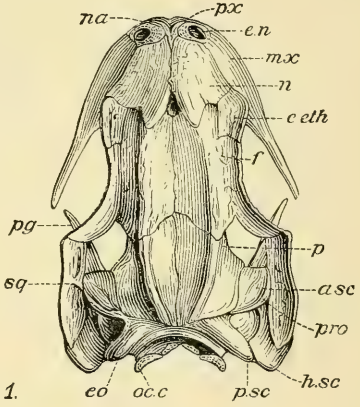

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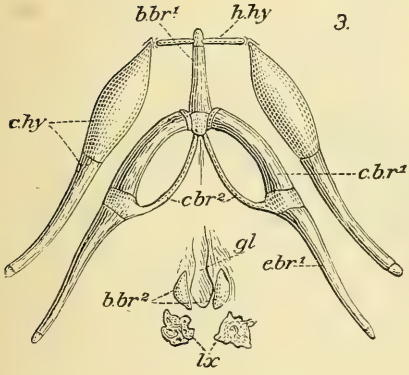

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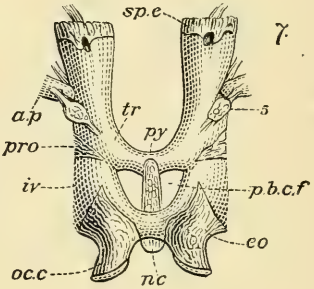

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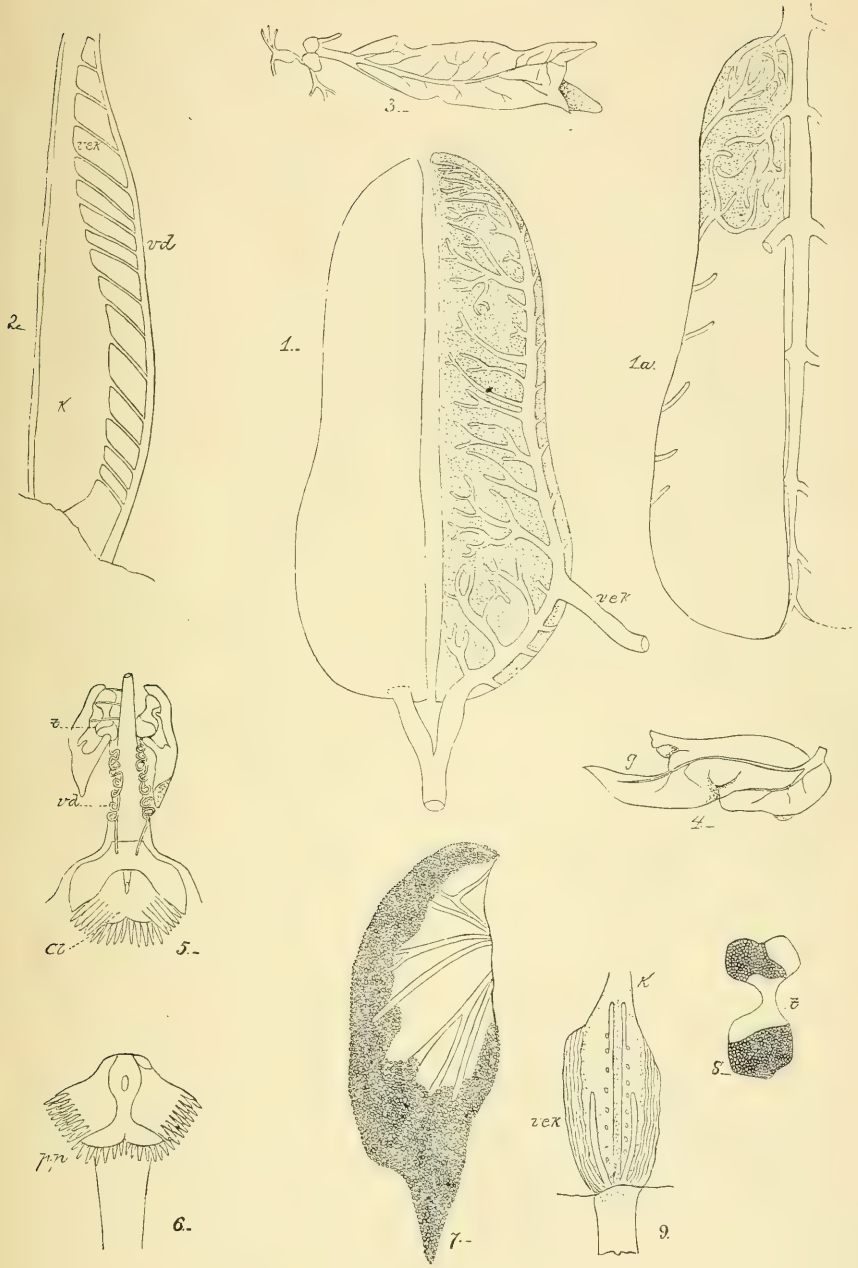

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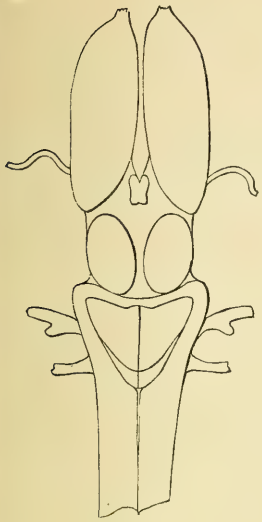

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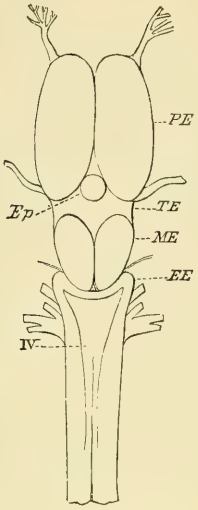

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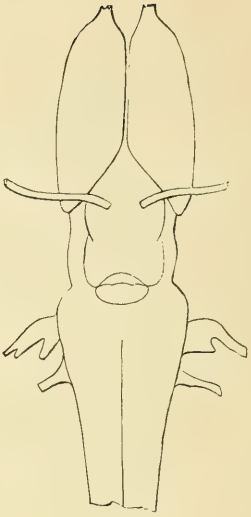

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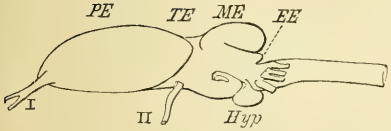

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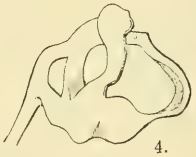

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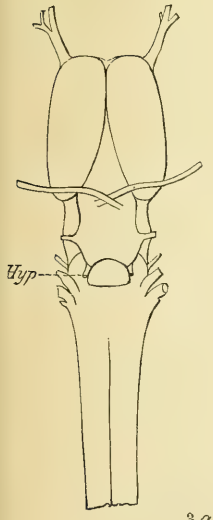

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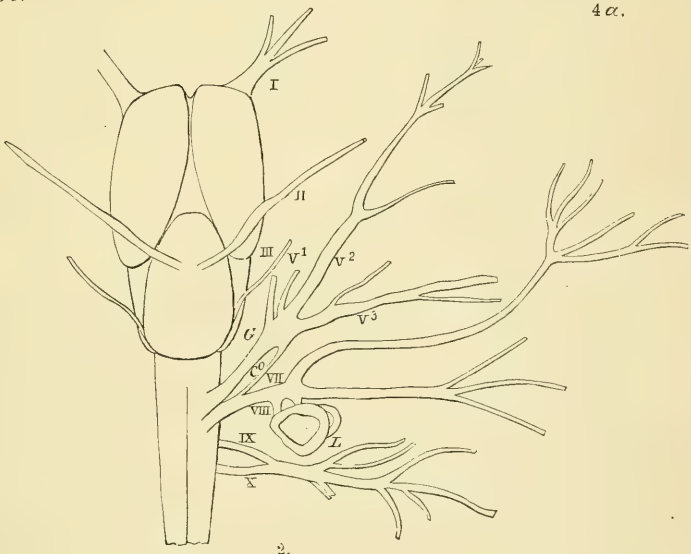

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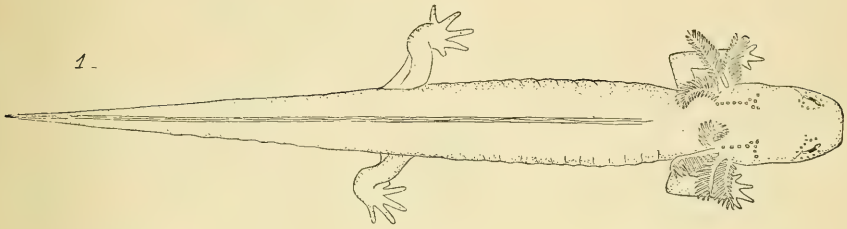
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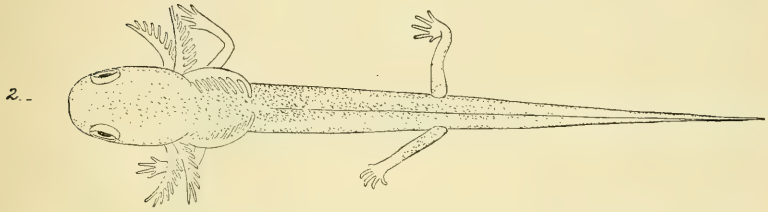
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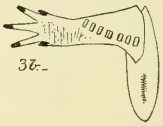
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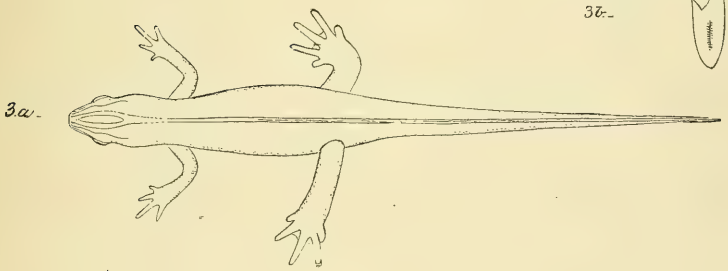
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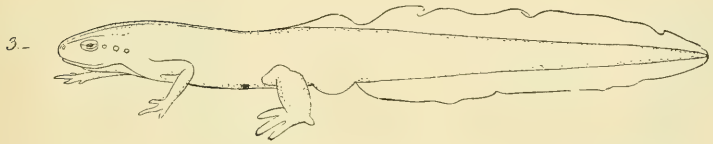
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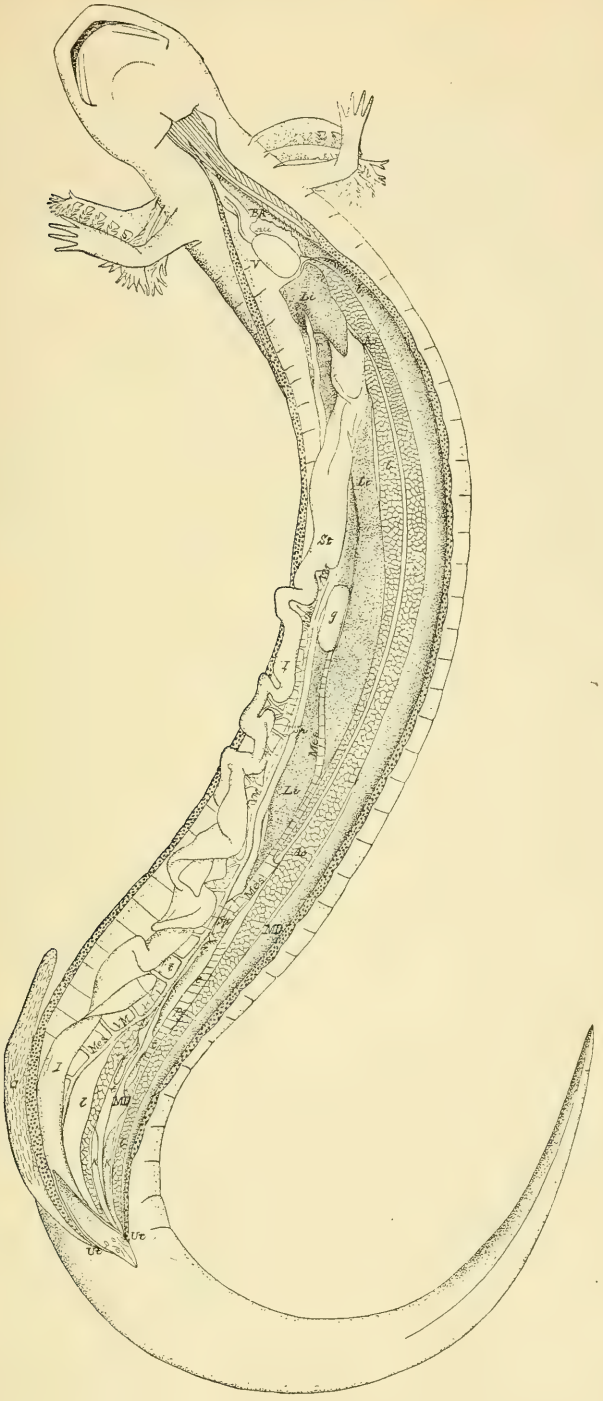

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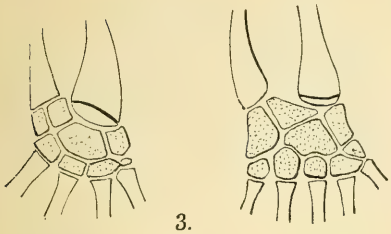

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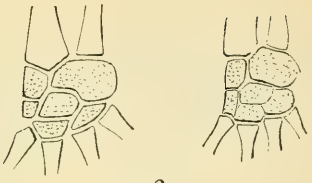

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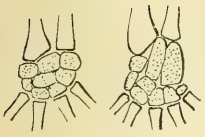

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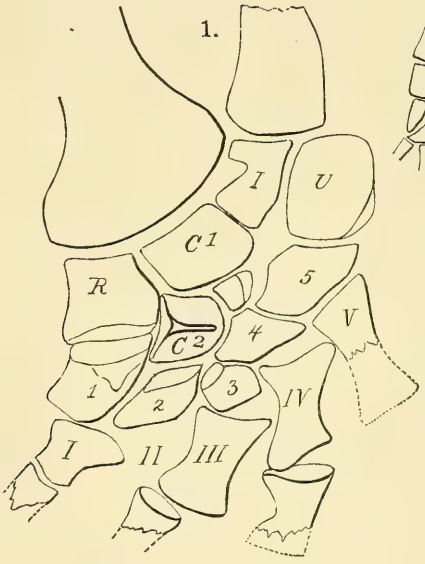

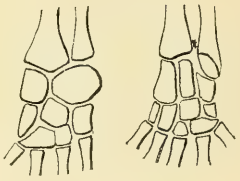

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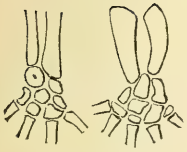

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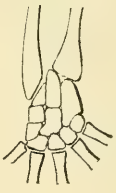

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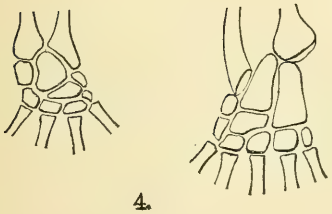

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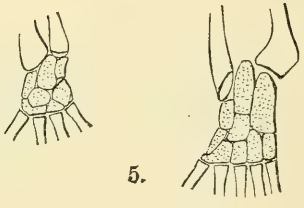

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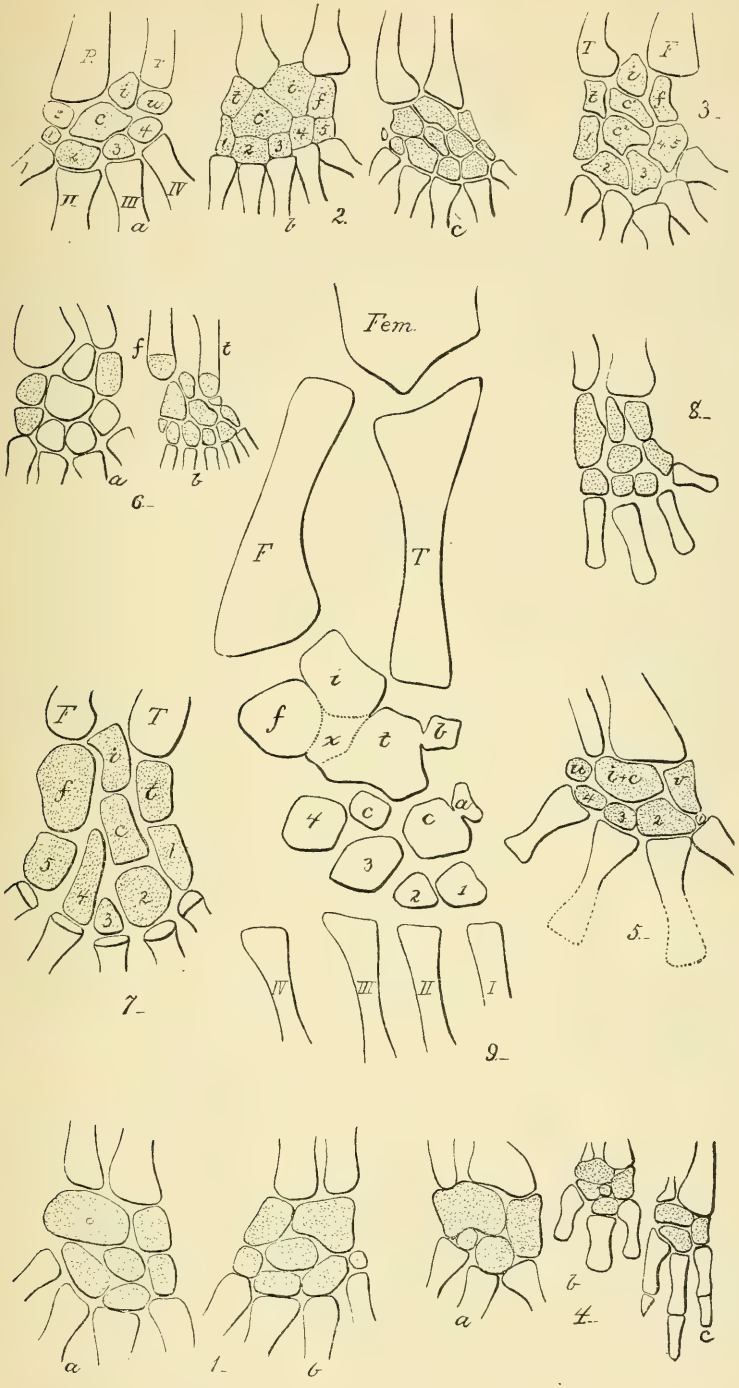
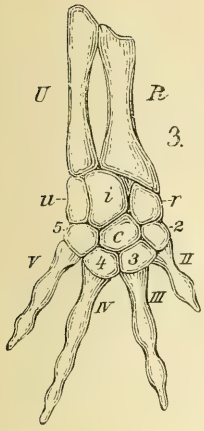


URODELA AND GANOCEPHALA.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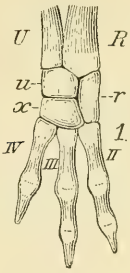
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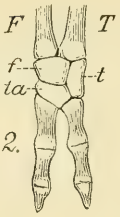
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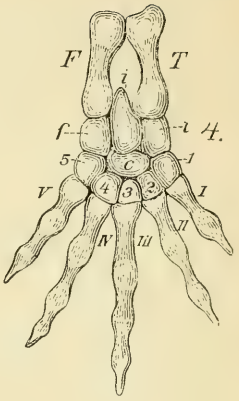
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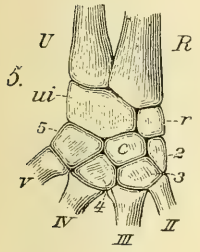
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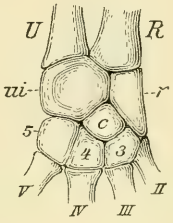
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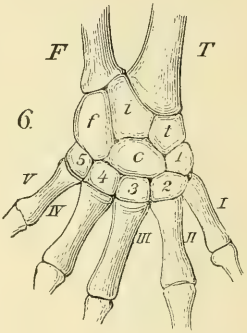
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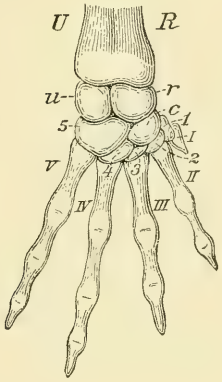
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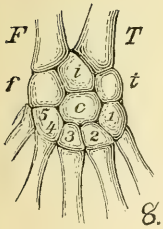
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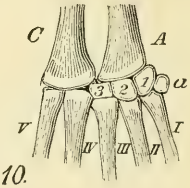
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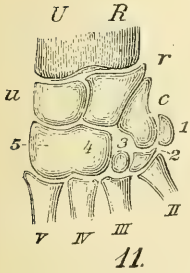
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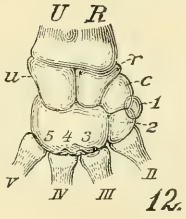
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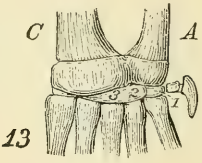
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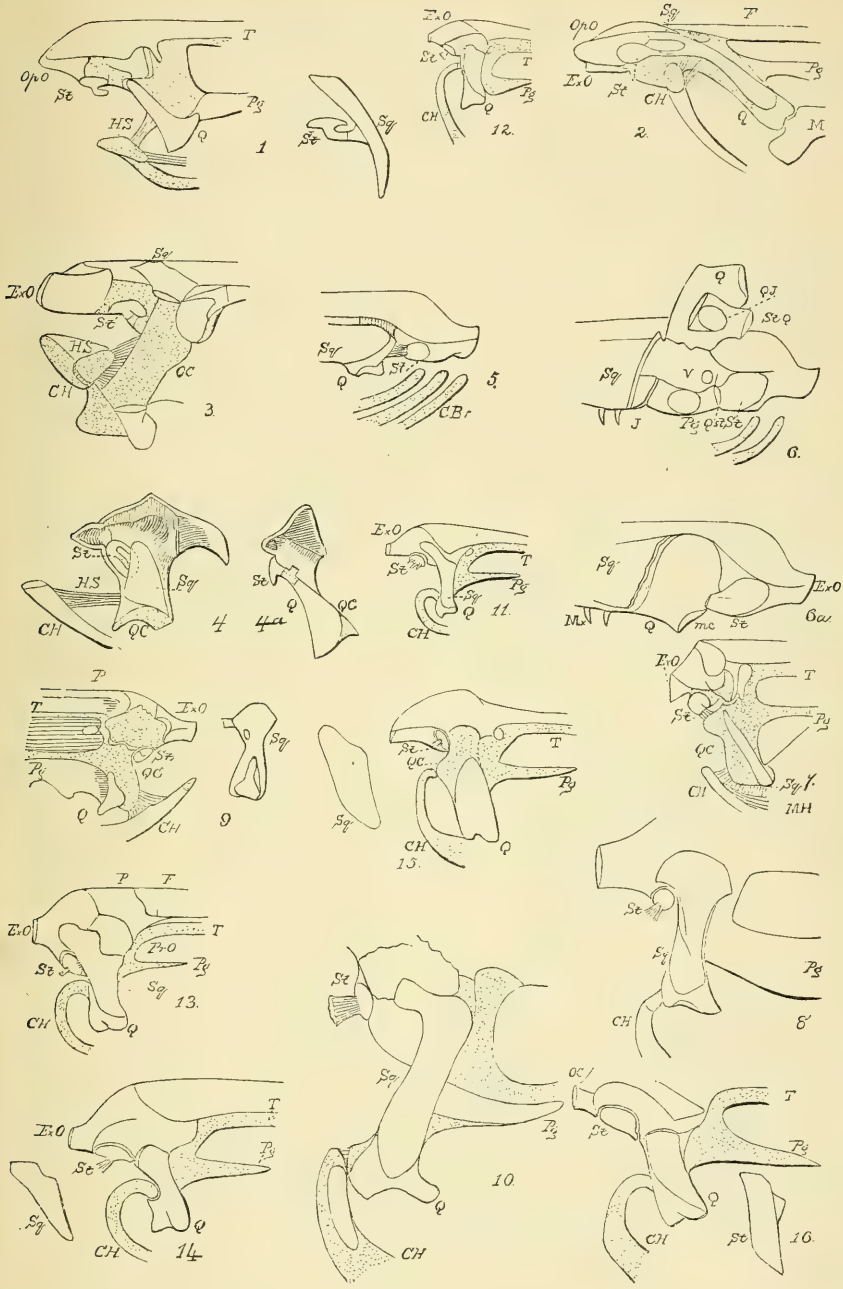
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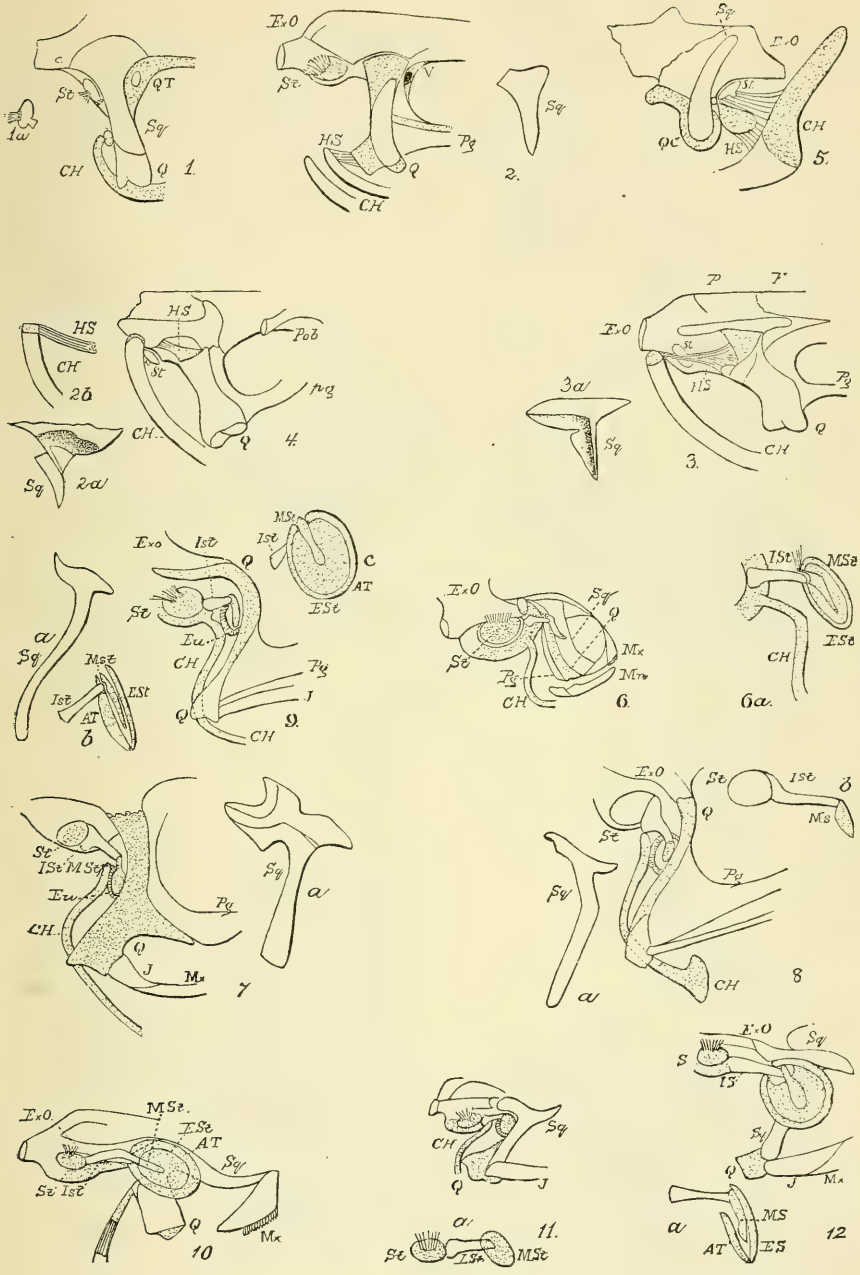
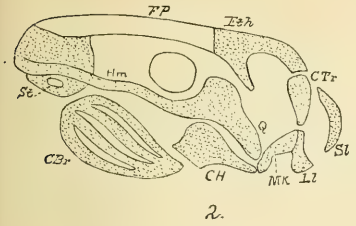


URODELA, TRACHYSTOMATA, AND SALIENTIA.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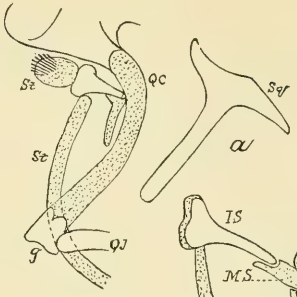
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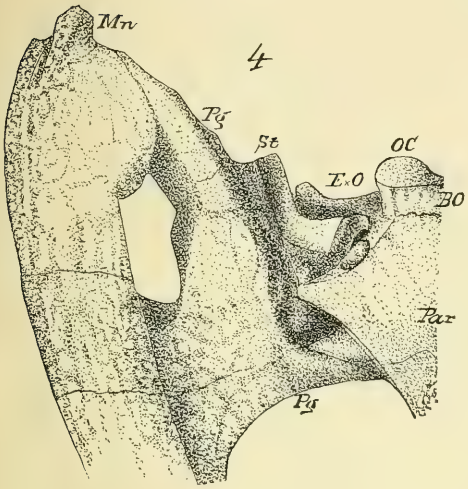
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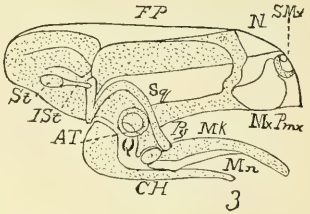
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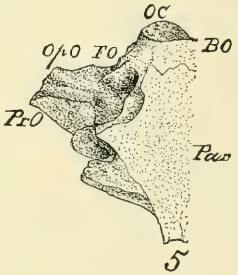
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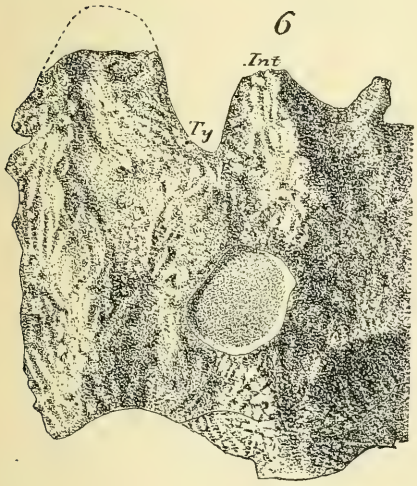
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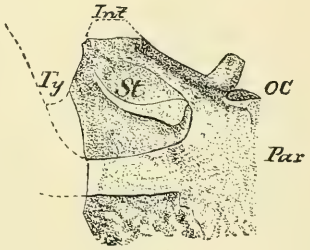
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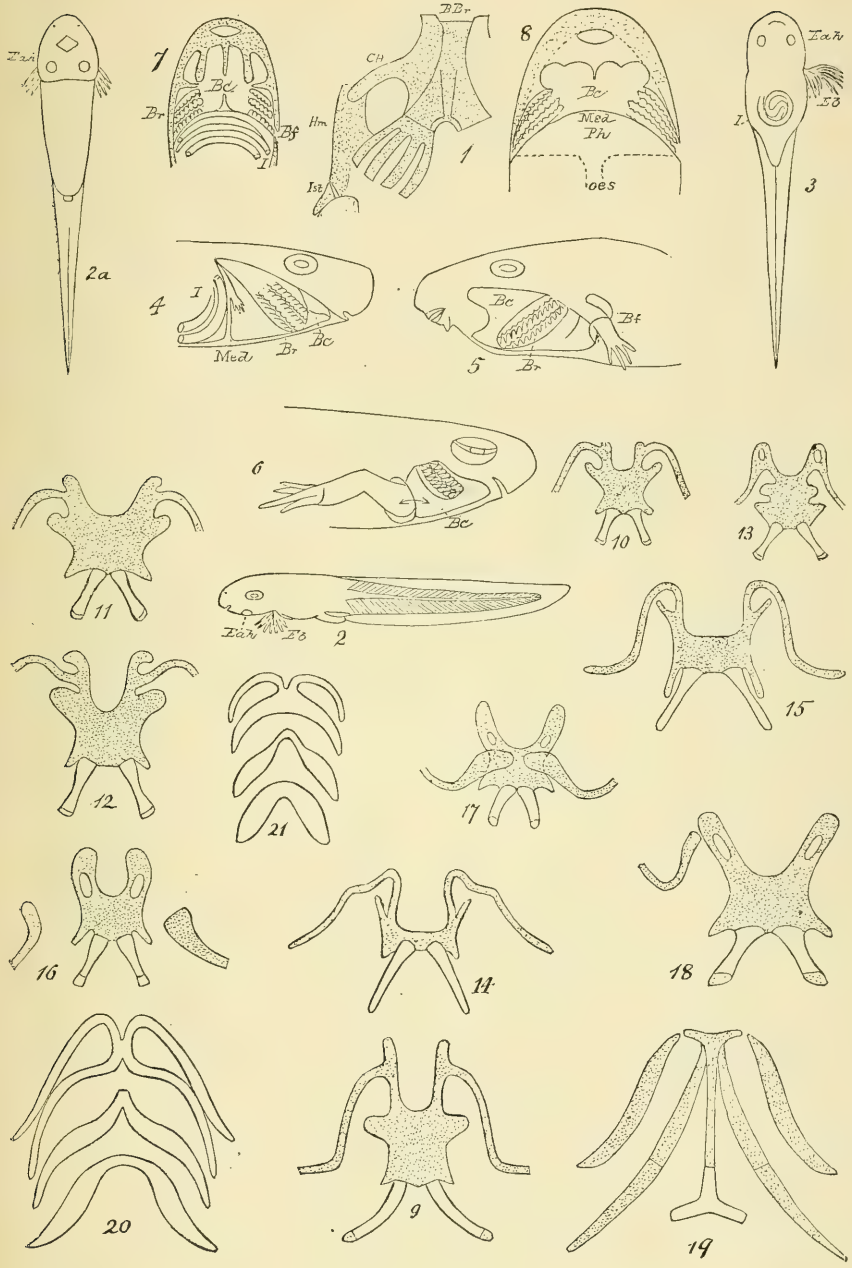
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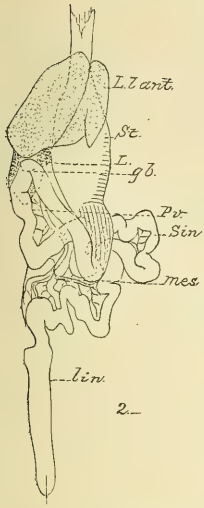
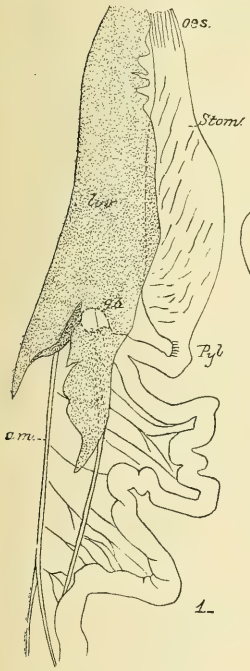
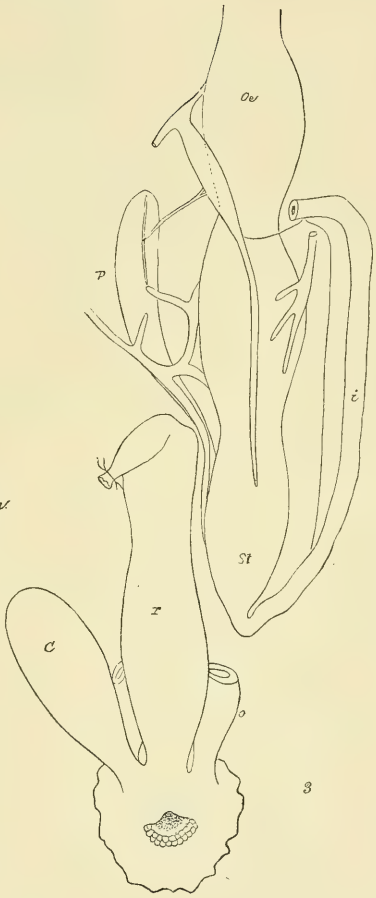
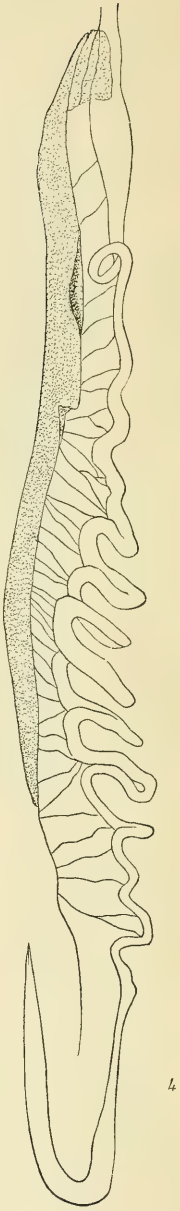


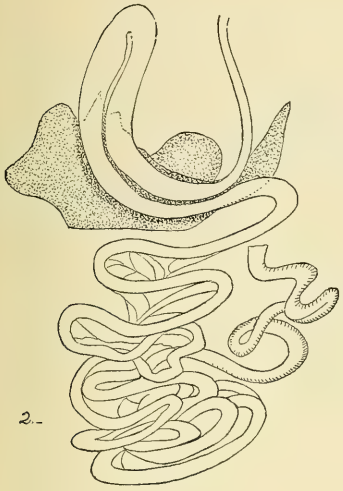






PROTEIDA AND URODELA.

URODELA AND SALIENTIA.



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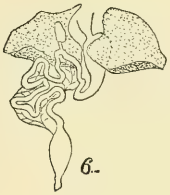

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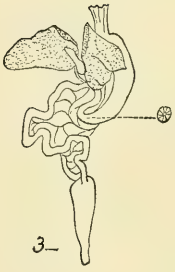

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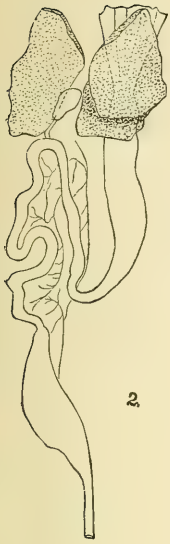

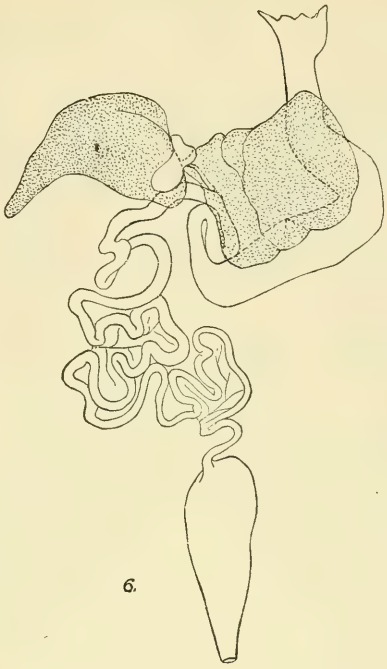

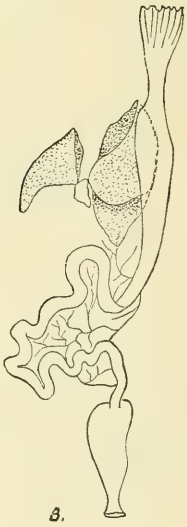

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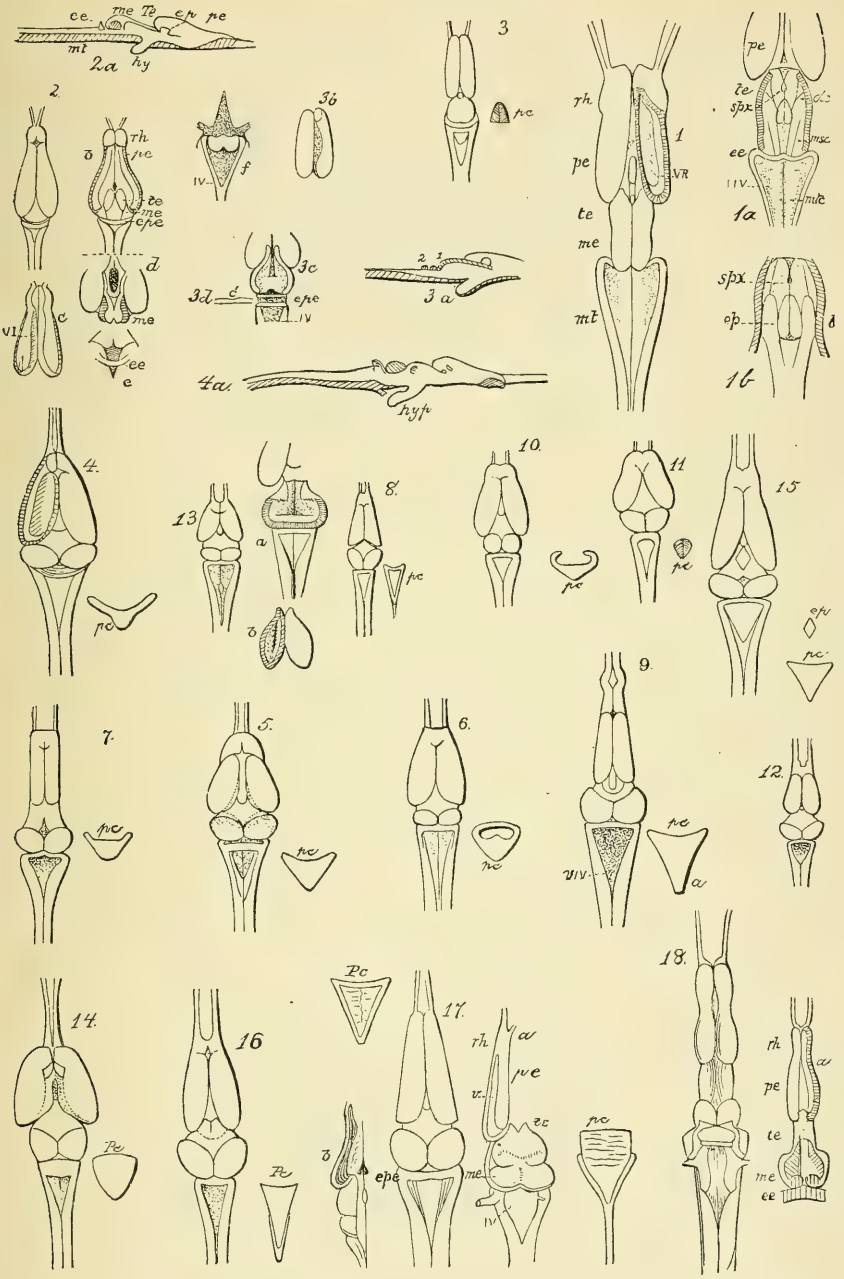
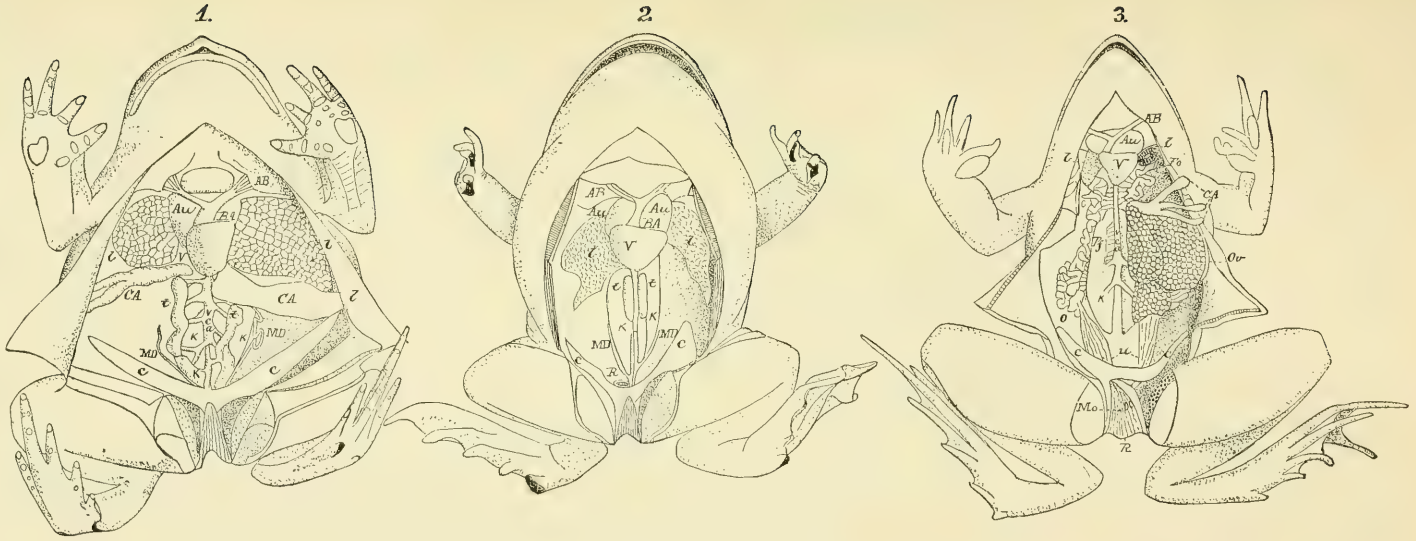
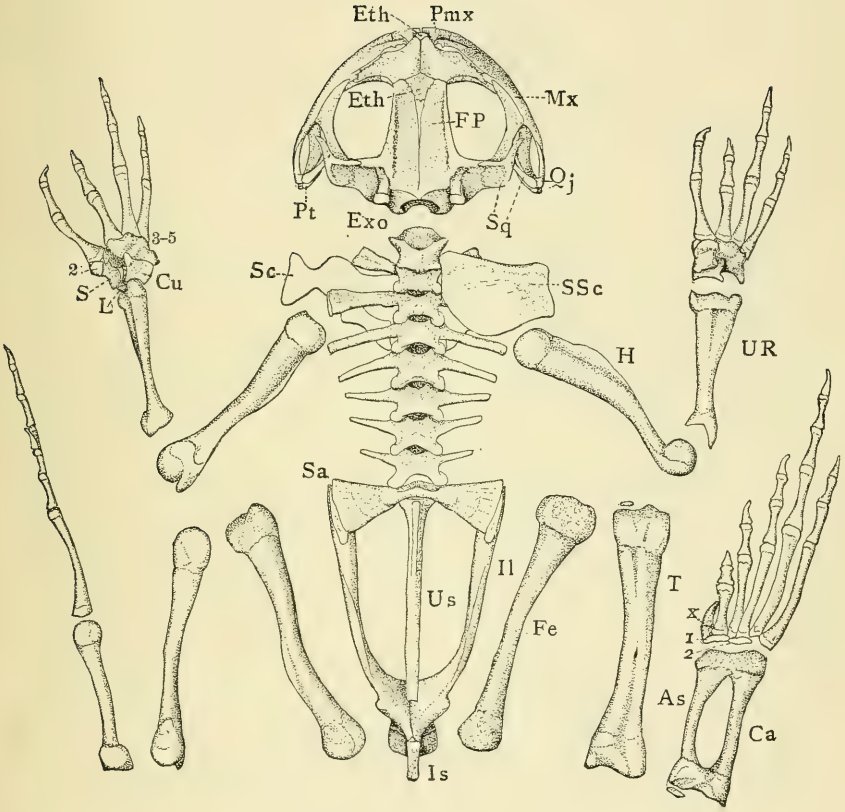


BRAINS OF URODELA, PROTEIDA, AND SALIENTIA.



BUFO, SCAPHIOPUS, AND RANA.



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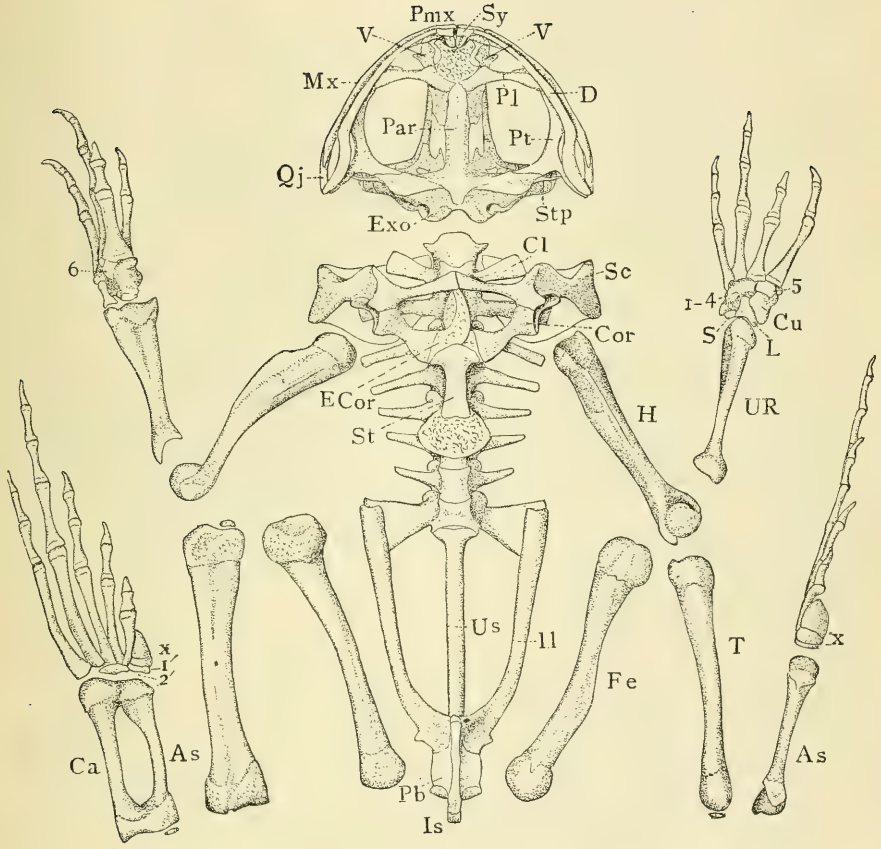

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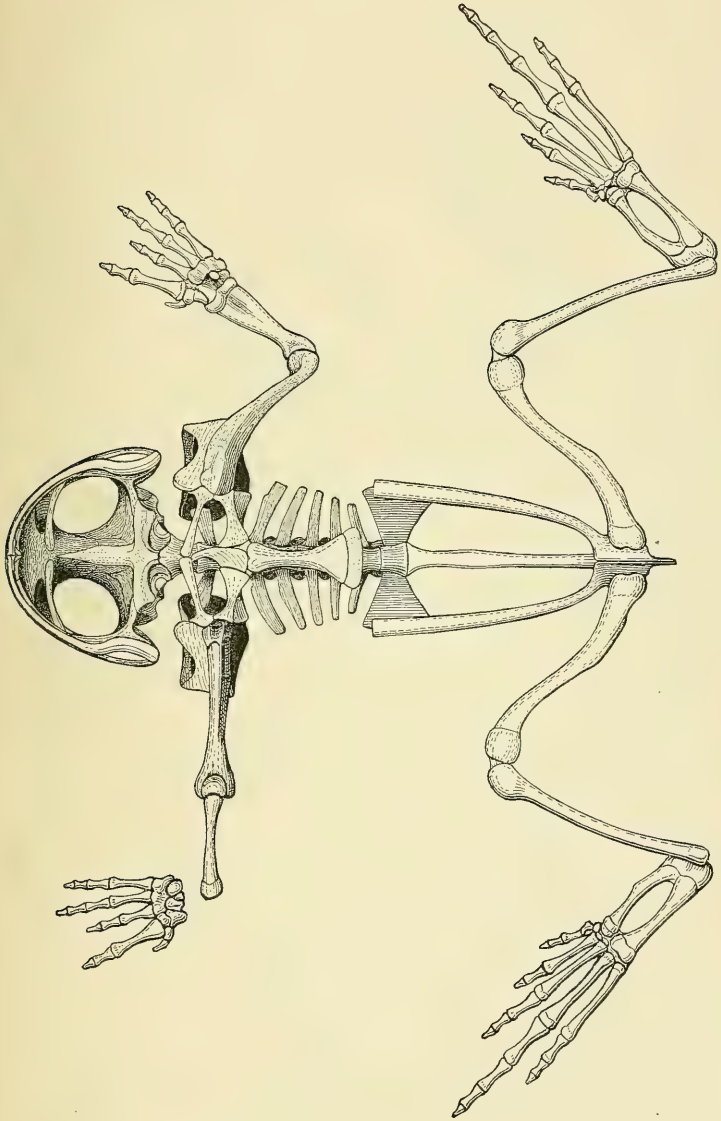

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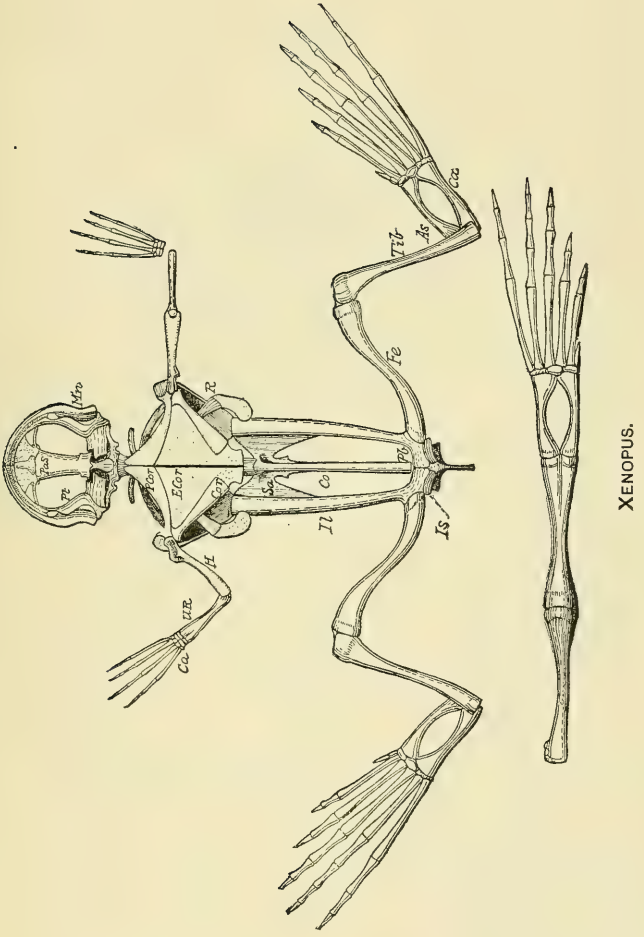
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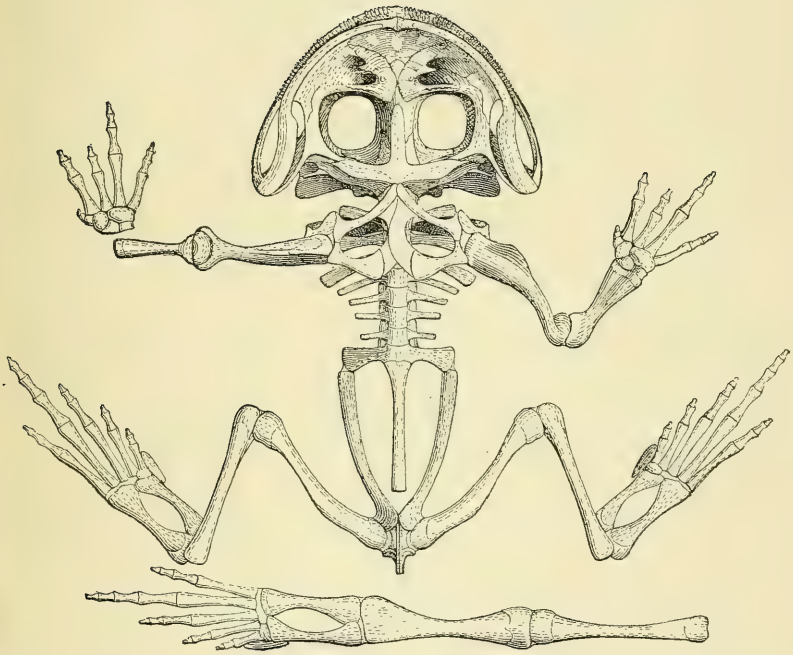

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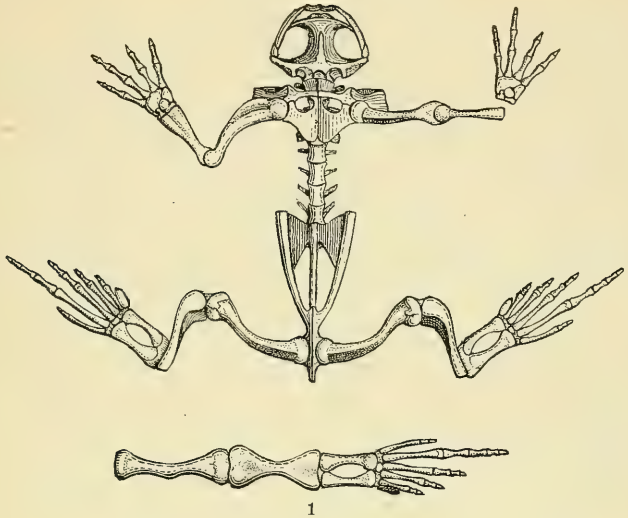

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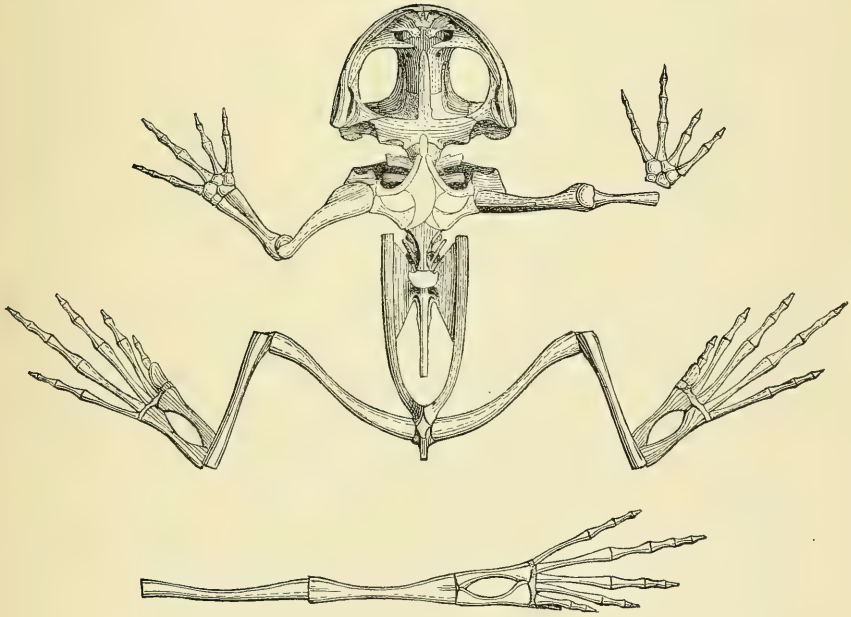

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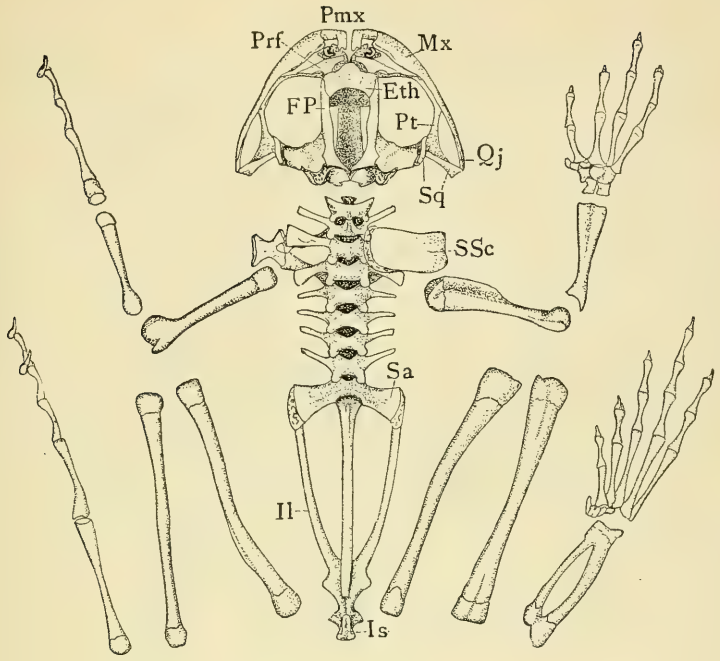

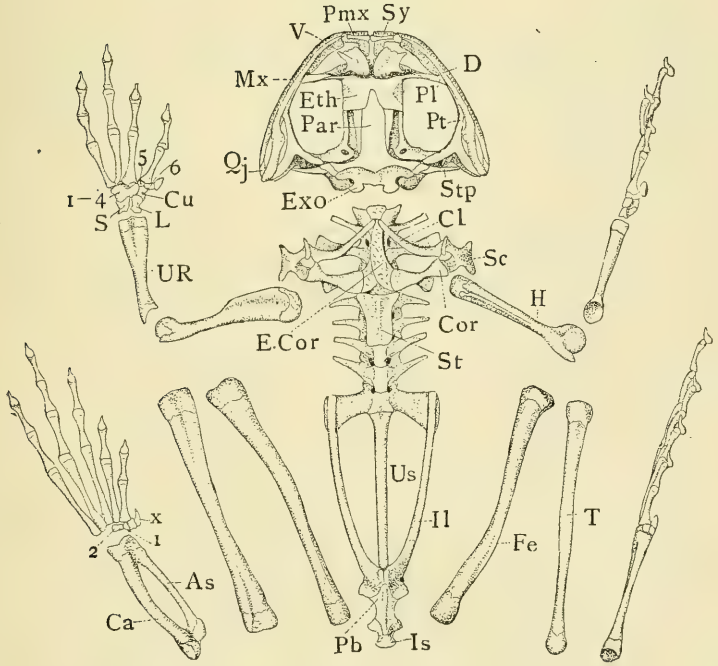

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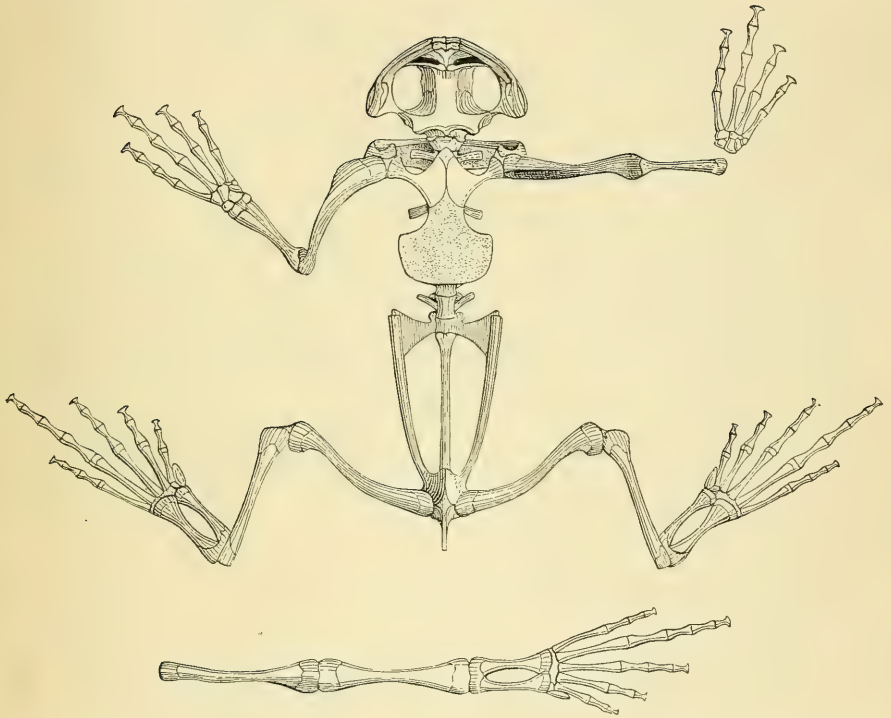

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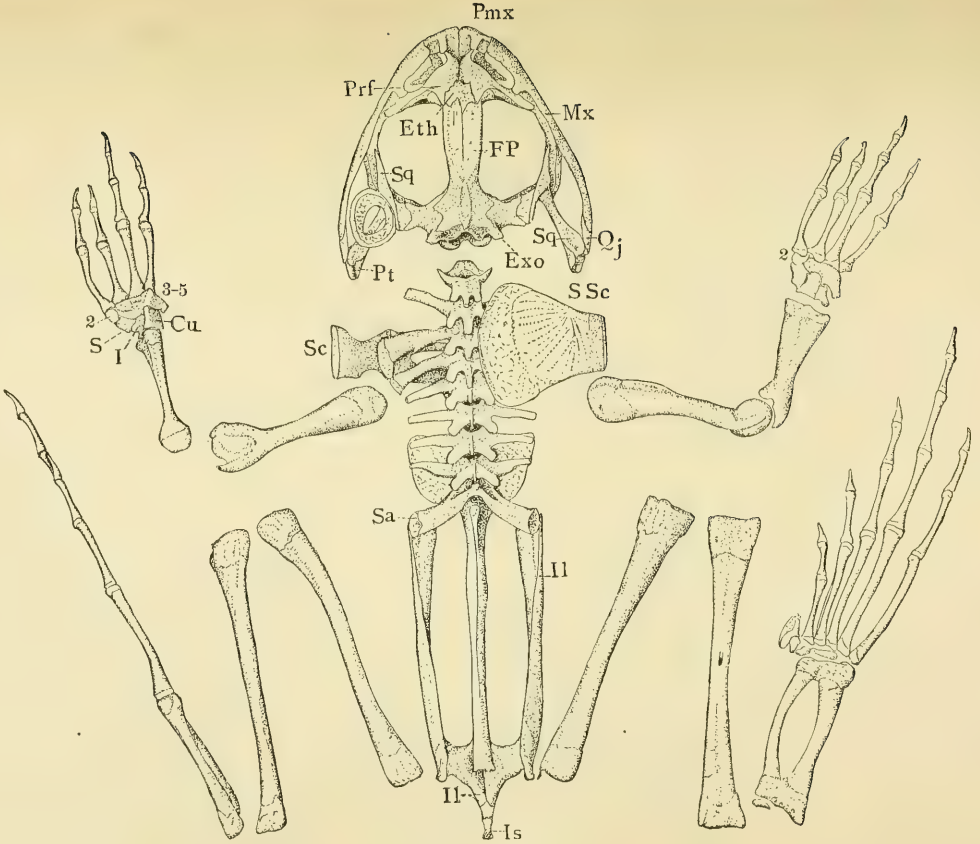

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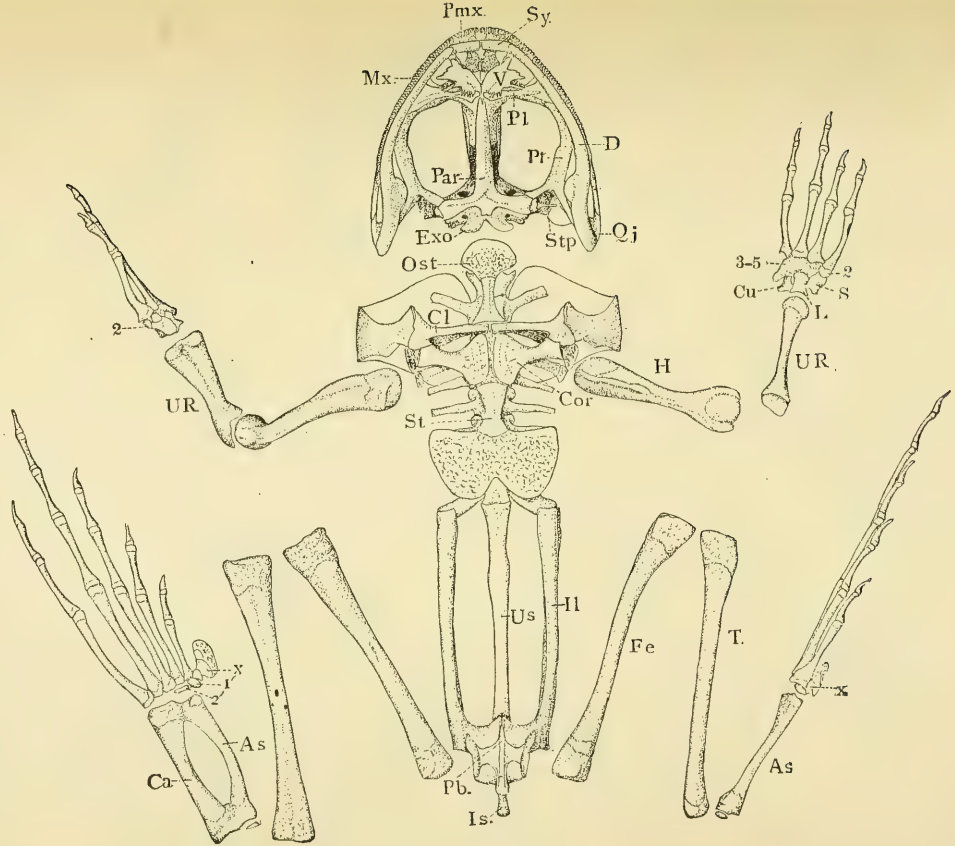

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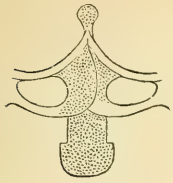
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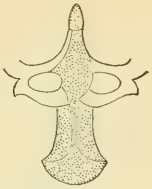
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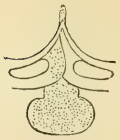
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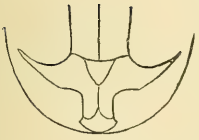
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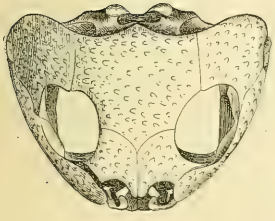
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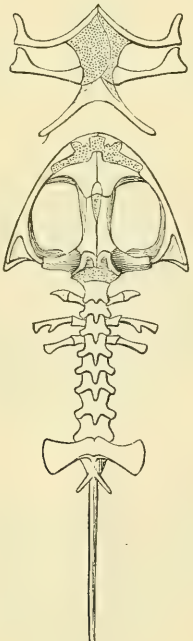
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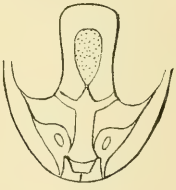
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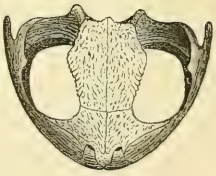
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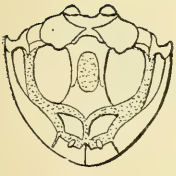
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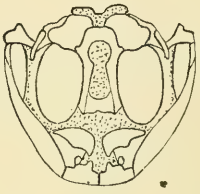
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DISCOGLOSSIDÆ AND SCAPHIOPIDÆ.

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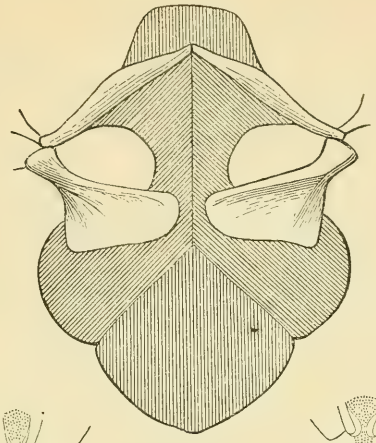

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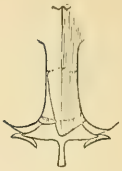

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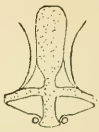

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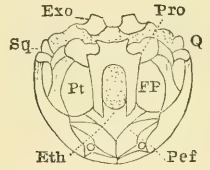

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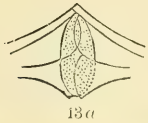

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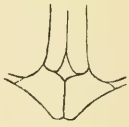

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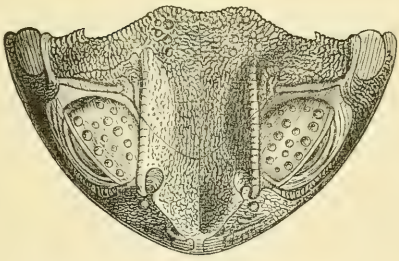

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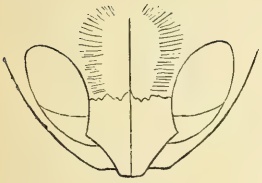

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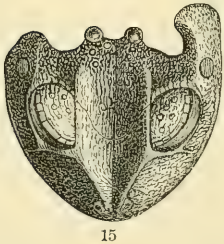

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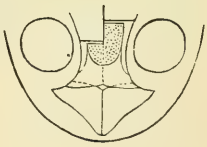

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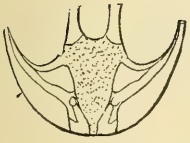
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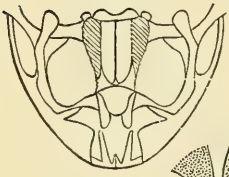
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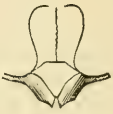
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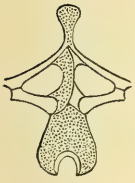
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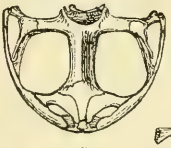
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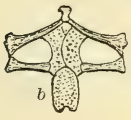
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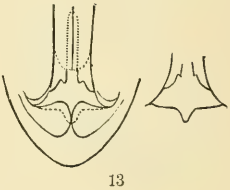
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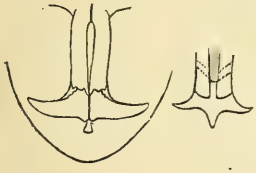
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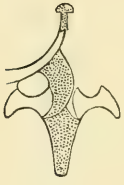
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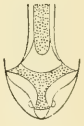
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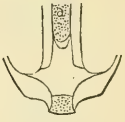
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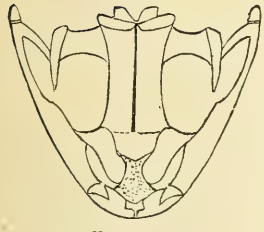
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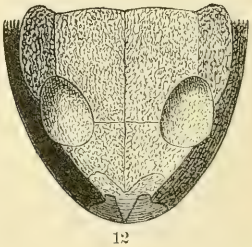
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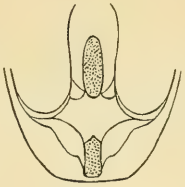
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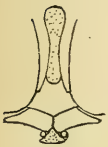
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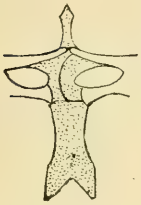
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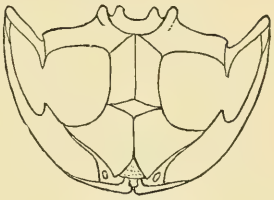
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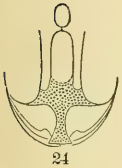
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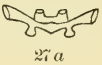
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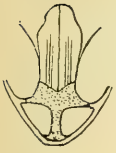
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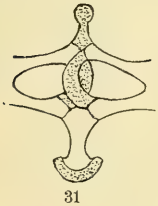
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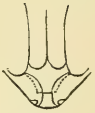
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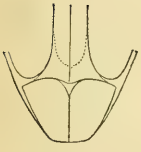
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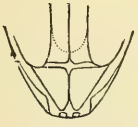
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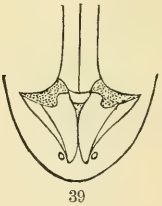
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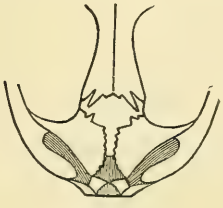
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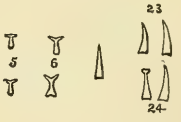

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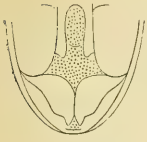
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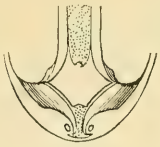
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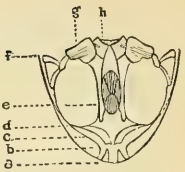

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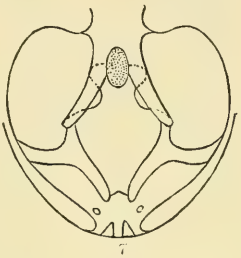
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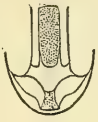
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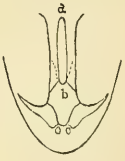

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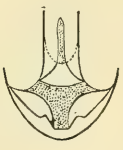
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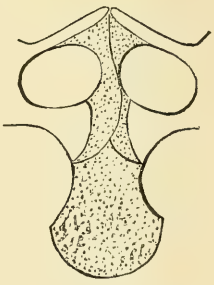
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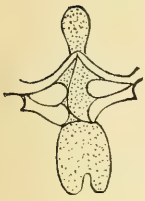
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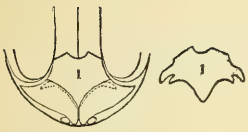
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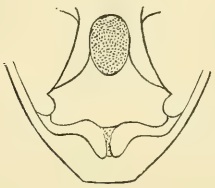
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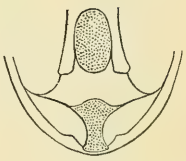
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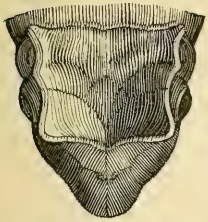

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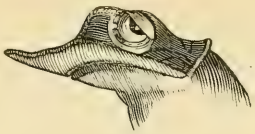

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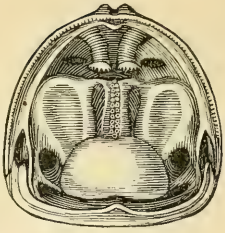

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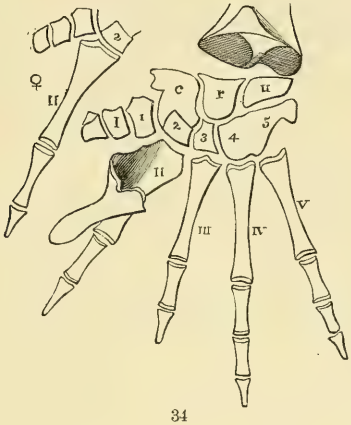

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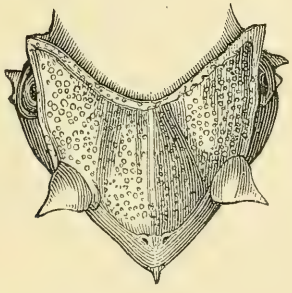

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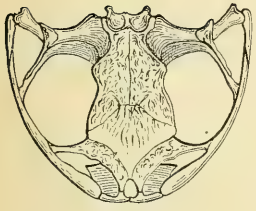

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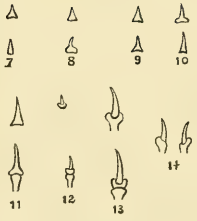

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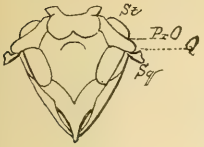

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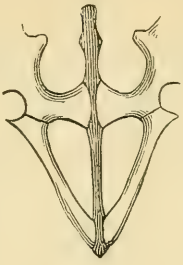
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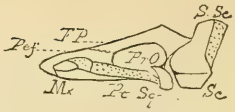

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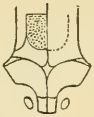
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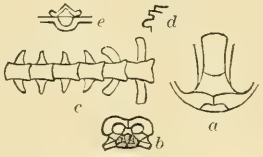

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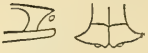
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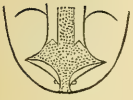
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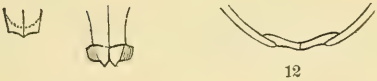

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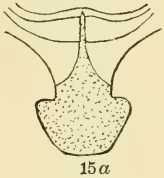
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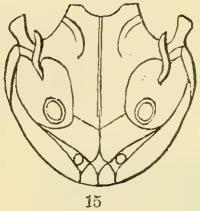
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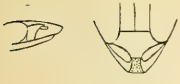
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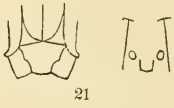
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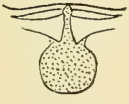
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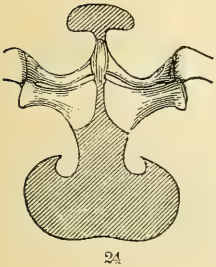
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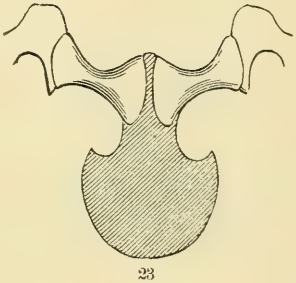
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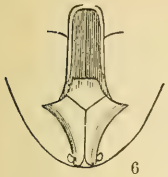
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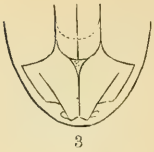
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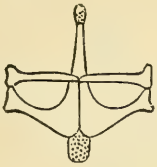
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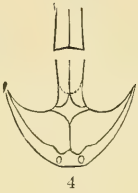
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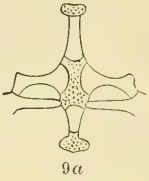
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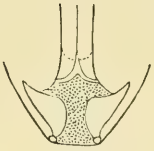
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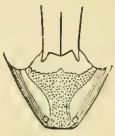
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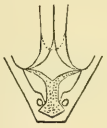
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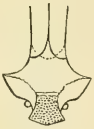
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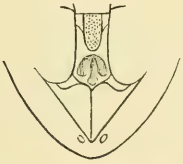
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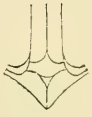
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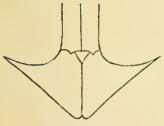
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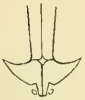
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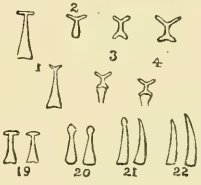

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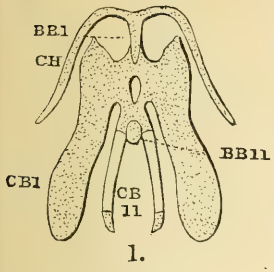

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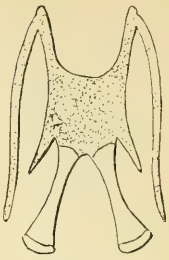
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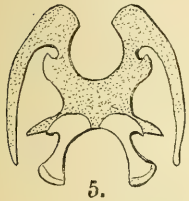
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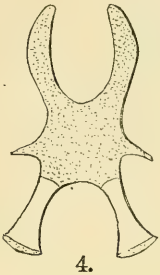
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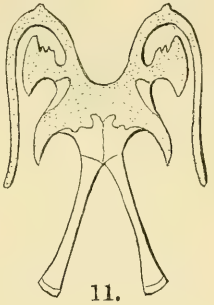
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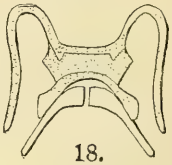
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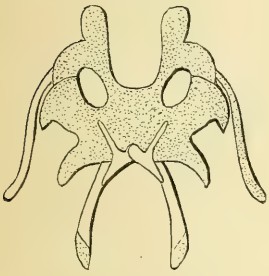
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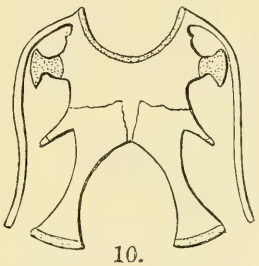
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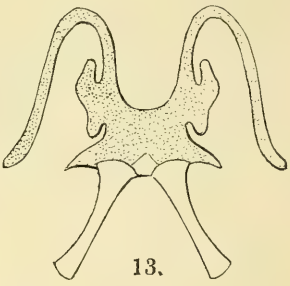
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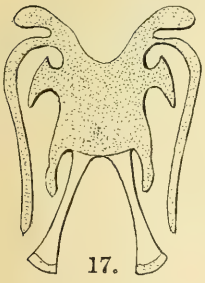
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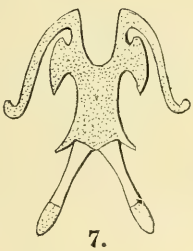
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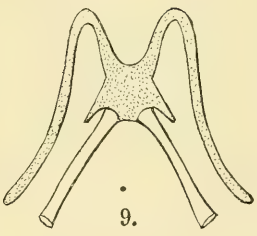
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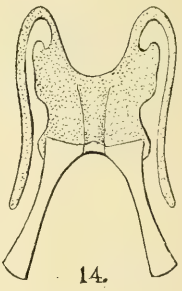
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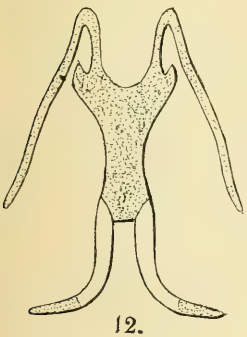
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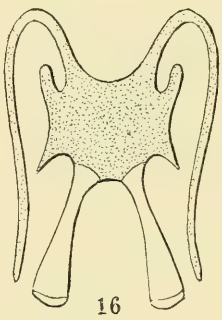
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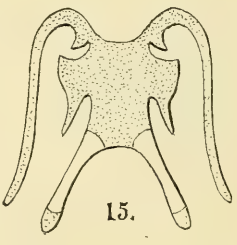
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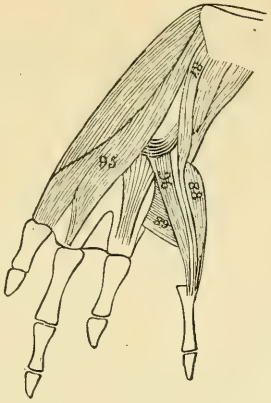

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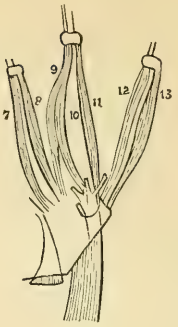

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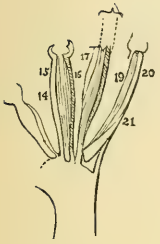

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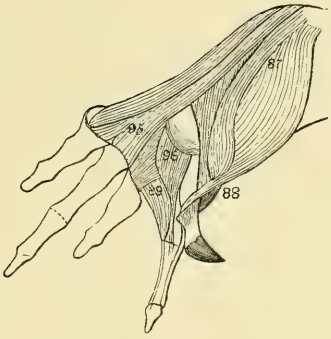

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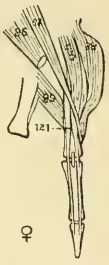

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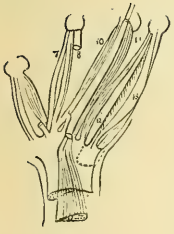

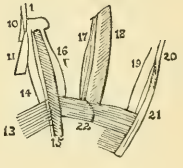

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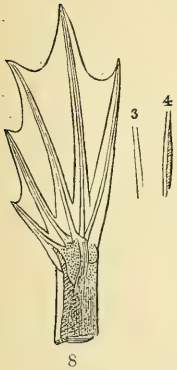

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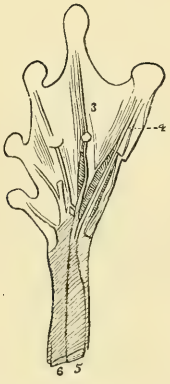

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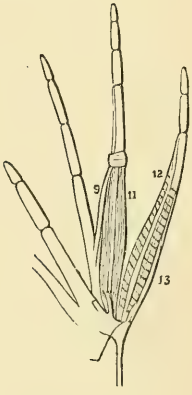

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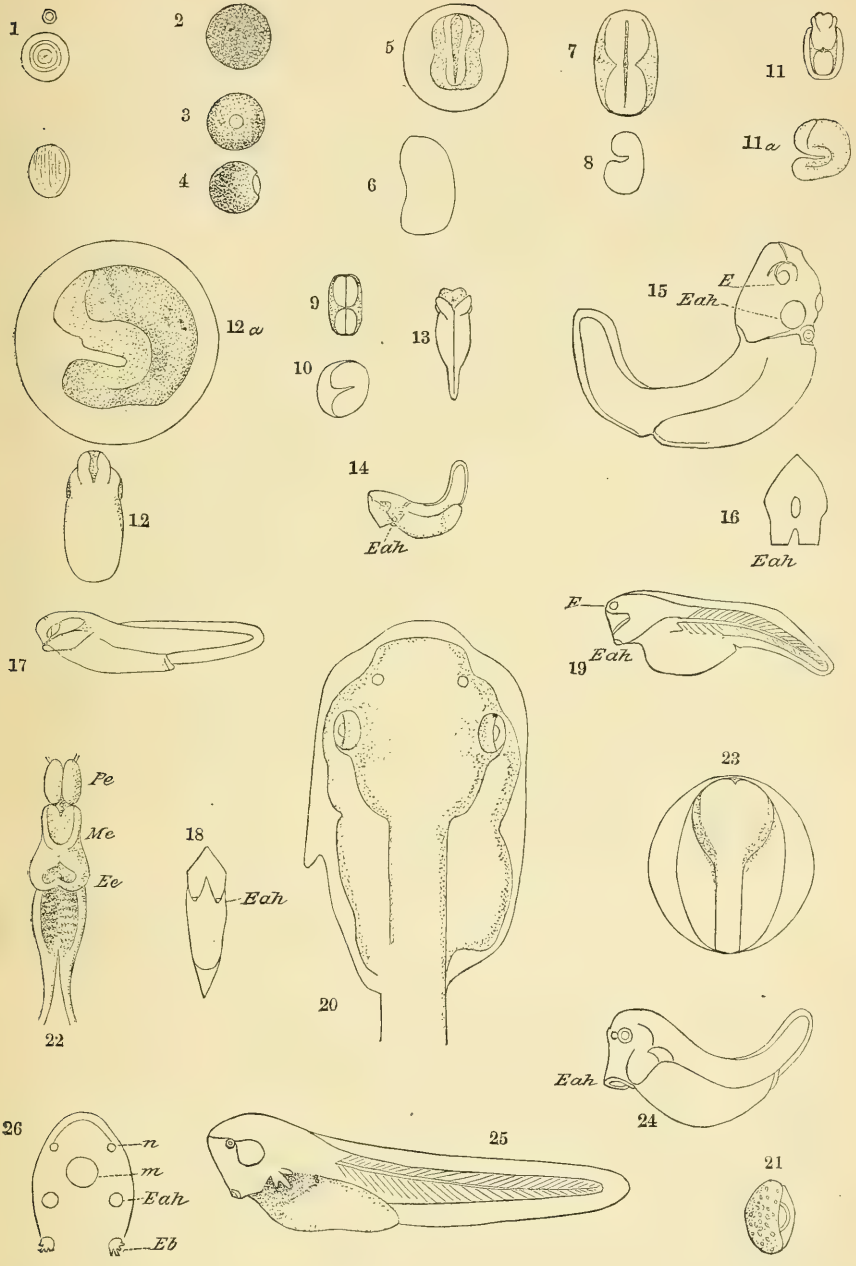

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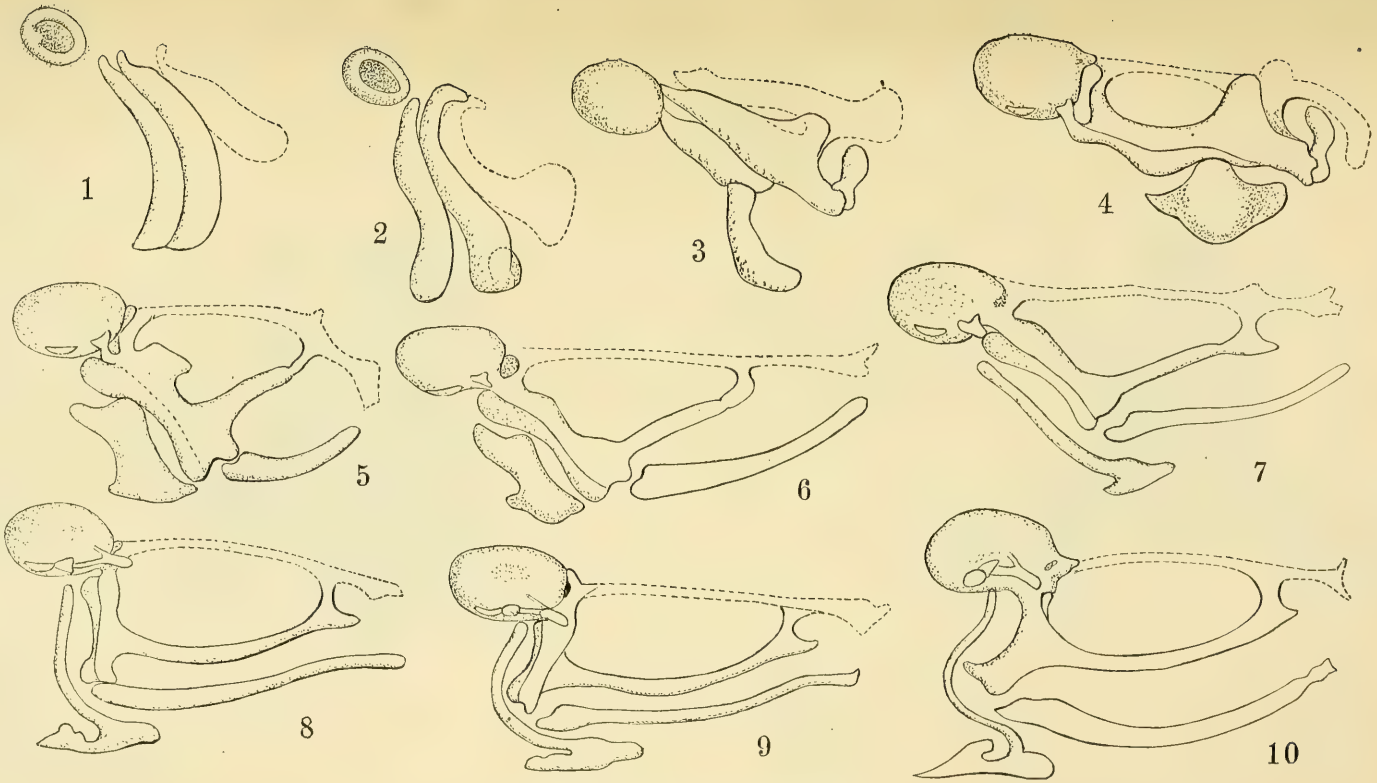

DEVELOPMENT OF ARCHES OF SALIENTIA.

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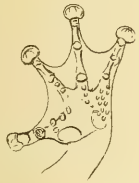

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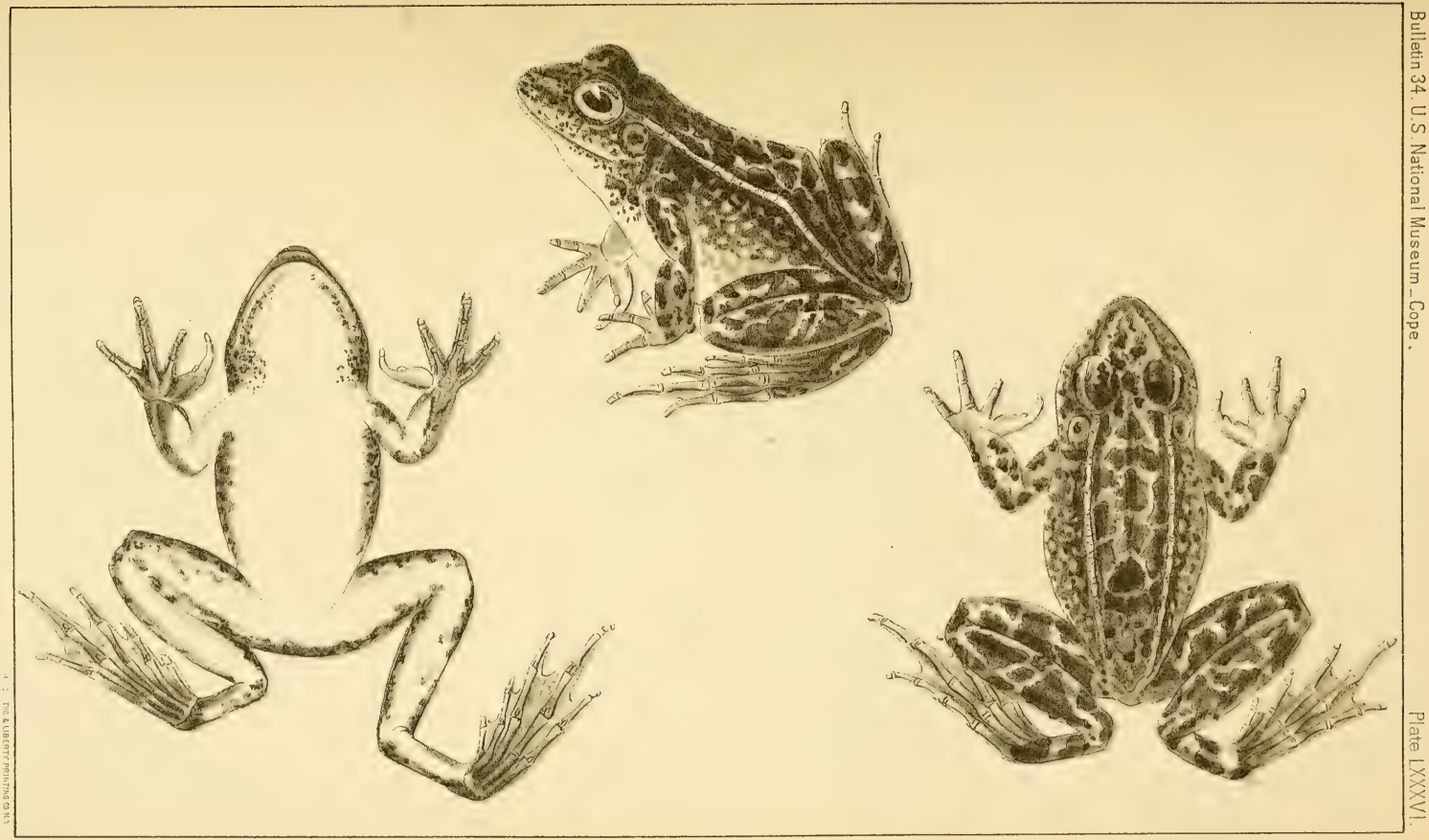

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